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FINAL REPORT

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DEVELOP AGRONOMIC PRACTICES FOR 'SMALL' POTATO PRODUCTION IN SASKATCHEWAN

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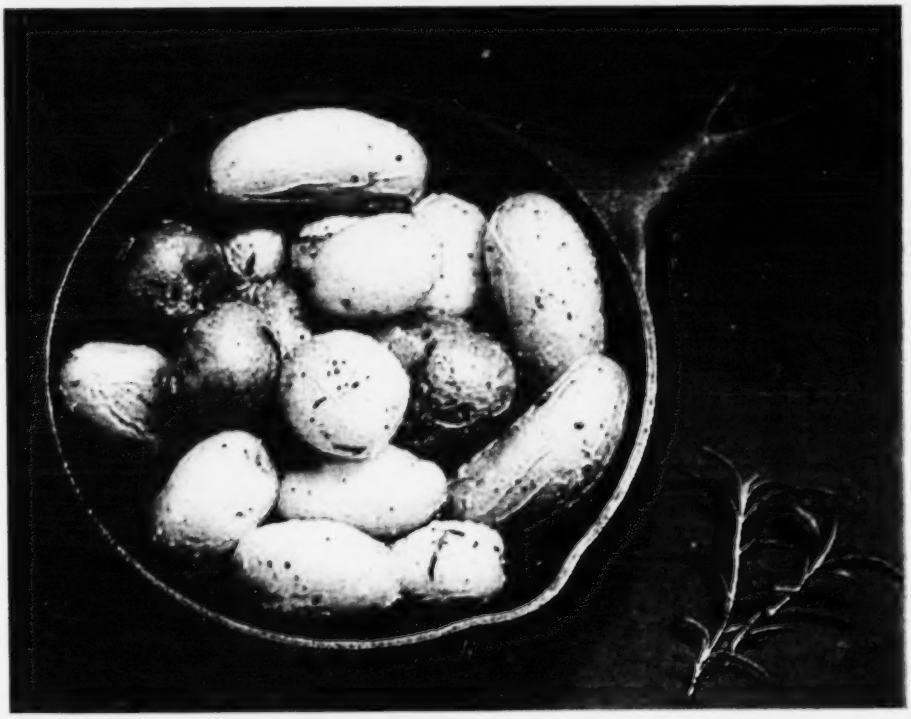
Develop Agronomic Practices for Small Potato Production in Saskatchewan

Final Report



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EXECUTIVE SUMMARY

Highly competitive potato markets and recent health issues associated with traditional fried and processed potatoes and potato products have compelled the potato industry to search for healthier alternatives. 'Small' potatoes are a healthier, fresh and non-fry option with economic potential. The success of producing high quality small potato cost-effectively depends on superior cultivars and appropriate agronomic practices. North American and Canadian small potato markets mostly target tubers between 20 mm and 40 mm in diameter. However, slightly larger size profiles (up to 20-50 mm diameter) are demanded by some market places. Cultivar choice and agronomic practices utilized to produce standard (larger) potato cannot be directly applied for producing small potato. Production practices should be suitably modified to optimize yields of small tuber profiles. This project, conducted at the Canada-Saskatchewan Irrigation Diversification Centre, was designed to identify superior germplasm, and develop cost-effective agronomic practices for producing 'small' potato under irrigation.

Objectives include:

(i) Evaluation of the adaptability of 'creamer' clones developed at the AAFC Lethbridge Research Centre and small potato cultivars from private breeders for irrigated production in Saskatchewan,
(ii) Identifying commercial potato cultivars and management practices targeted for small potato production, and
(iii) Developing agronomic practices including seed size, plant spacing, fertility management, and harvest techniques for maximizing yield of contrasting small potato cultivars.

Summary of findings from this project:
- Of the many AAFC clones tested CV96044-3 and V1241-1 appeared to be superior clones. However, small potato cv. Operle tested only in 2009 outyielded CV96044-3 by three-fold. Further work is needed to evaluate the superiority of Operle for small potato production in Saskatchewan.
- Optimum marketable yield were obtained when the crop was top-killed at 10 week from planting. Delaying harvest generally did not change marketable yield in many clones, but increased oversize yields and the proportion of oversized tubers relative to marketable tubers.
- Marketable yields can be higher for markets seeking larger size grades.
- Larger seed produced more mainstems, higher Leaf Area Index, marketable and over-size yields than smaller seed.
- Closer 15 cm seed-piece spacing generally produced higher marketable and oversize yields than the wider 20 cm spacing.
- Nitrogen rate and timing had variable effects on marketable and oversize yield for the various cultivars. The general trend was that the high N levels (300 – 400 kg N/ha) produced lower marketable and oversize yields than low N application.

- Cultivars responded differently to top-kill with and without flailing. Marketable yield responses were quite variable depending on cultivars. Generally, top-kill without flailing produced higher oversize yields indicating that flailing prior to desiccation is a preferred option to control tuber sizing.
- Delaying top-kill by one week had no effect on marketable yields, but increased the yield of oversize tubers compared to early top-kill
- Further agronomic refinements are needed to adopt table potato cultivars such as AC Peregrine and Norland for small potato production.
- The yield responses would be different if larger tuber size profiles are included in the marketable category.

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INTRODUCTION

Saskatchewan is likely the best place in North America where potato expansion can occur. The limited extent of potato production, minimal disease pressures due to low relative humidity, low land cost, large land base, and availability of irrigation water makes Saskatchewan one of the lowest cost potato producers in North America with tremendous expansion potential. Potato production is the leading sector in the horticulture industry in Saskatchewan. Currently, Saskatchewan is a major player in the seed potato industry. Saskatchewan also produces high quality table potato, and has the potential for growing high quality processing potato.

Highly competitive markets and increasing production costs has substantially reduced profit margins to potato producers. Recent health issues such as acrylamide associated with cancer in traditional fried or processed potatoes and potato products has compelled the potato industry to search for healthier alternatives. 'Small' potatoes are one such healthier fresh and non-fry option with economic potential. Small potato production is a viable alternative to traditional potatoes. 'Small' fresh potato and its non-fry derivatives offer an economically viable alternative to the potato producers. The demand for small potato is increasing very rapidly in the USA, Europe, and Canada. Considerable acreage of small potato is being grown in the Outlook irrigation area to meet the demand of this expanding market.

Small potato markets in North America including Canada target tubers between 20 mm and 40 mm in diameter. The success of cost-effectively producing high quality small potato of target size grades, depends on superior cultivars and appropriate agronomic practices.

Agronomic recommendations used for standard (larger) potato production cannot be directly applied for producing small potato. In small potato production the objective is to maximize yields of smaller tubers as demanded by the target market. As such, the crop is top-killed relatively early, when the plants are still actively growing, to limit tuber sizing. Production practices include selection of suitable cultivar and developing appropriate agronomic practices to optimize yields of small potato while maximizing returns. The differences and challenges in growing small potato compared to conventional potato include cultivars that produce high yields of small size profile, earlier top-kill and harvest to maximize target size grades, and other production practices to optimize yields of small tubers.

This study is designed to identify superior germplasm, and develop cost-effective agronomic practices for producing 'small' potato under irrigation in Saskatchewan. Specific projects include:

- Screening 'small/creamer' clones developed at the AAFC Lethbridge Research Centre and private breeders.
- Identifying commercial potato cultivars suited for small potato production.
- Determining optimum seed size for maximizing yield of small potato.
- Developing optimum plant spacing and harvest timing to maximize tuber yields of target market grades.
- Develop efficient fertilizer management practices.
- Identifying suitable top-kill dates to maximize target tuber size grades for different cultivar.

GENERAL METHODOLOGY

Field studies were conducted at the Canada Saskatchewan Irrigation Diversification Centre, Outlook during the summer of 2007 through 2009. The soil at the test sites was a sandy loam soil. Cultivars/clones examined in this project included nine creamer clones from AAFC Lethbridge Research Centre, four commercial cultivars (Alpha, Bintje, Norland, and AC Peregrine), and four small potato cultivars (Baby Boomer, Blushing Belle, Piccolo, and Operle) from private breeders.

The crop was raised using standard management practices with treatments applied appropriately as required by the different tests. Eptam 8E (6.2 l/ha) was applied as pre-plant herbicide (Plate 0-1). Poast Ultra was applied as post-emergent herbicide to control grassy weeds when needed. The crop was planted in the standard hill/furrow system (Plate 0-2). Nitrogen at 250 kg N/ha (half at planting and half at hilling), phosphorus at 120 kg P_2O_5/ha and potash at 100 kg K_2O/ha (at planting) were applied for the crop except for the nitrogen management trial where fertilizer was applied according to the protocol. The crop was hilled (Pate 0-3) twice, the first hilling approximately four weeks after planting and the second hilling 10 to 12 days later. Bravo 500, Tattoo C, and Acrobat MZ fungicides were applied for disease control. Admire and Ripcord was applied for insect control. Soil moisture was maintained above 60% Field Capacity using overhead sprinkler irrigation (Plate 0-4).

Growth attributes such as emergence, mainstem count, flowering, and Leaf Area Index (Plate 0-5) were recorded during the growing season.

Harvest dates were determined according to protocol, i.e. an average of two tubers per hill reached marketable size (20-40 mm diameter). Plots were flailed and desiccated (Plate 0-6) with Reglone (2.47 L of Reglone at 1000 L of water per ha). A second application of Reglone was given at a later stage to promote vine kill and skin set. Tubers were harvested (Plate 0-7) at proper skin set. The harvested tubers were graded (Plate 0-8) according to tuber diameter. The size grades included 20-25 mm, 25-30 mm, 30-35 mm, 35-40 mm, 40-45 mm, 45-50 mm, and >50 mm. In the following discussion, tubers between 20 mm and 40

mm are considered 'marketable' grade and tubers larger than 40 mm are considered oversize.

Climatic Conditions:
The 2007, 2008, and 2009 growing seasons experienced variable climatic conditions (Figures 0-1, 0-2) that impacted growth and yield of potatoes. The 2007 and 2008 growing season was relatively warm and dry. In 2007, high temperatures during the growing season, particularly during tuber bulking, and hail damage on July 31, August 17 and August 18 (Plate 0-9) caused considerable crop damage that resulted in significant yield losses for all tests. The temperature in the latter part of August exceeded 35°C and caused considerable tuber deformity (Plate 0-10).

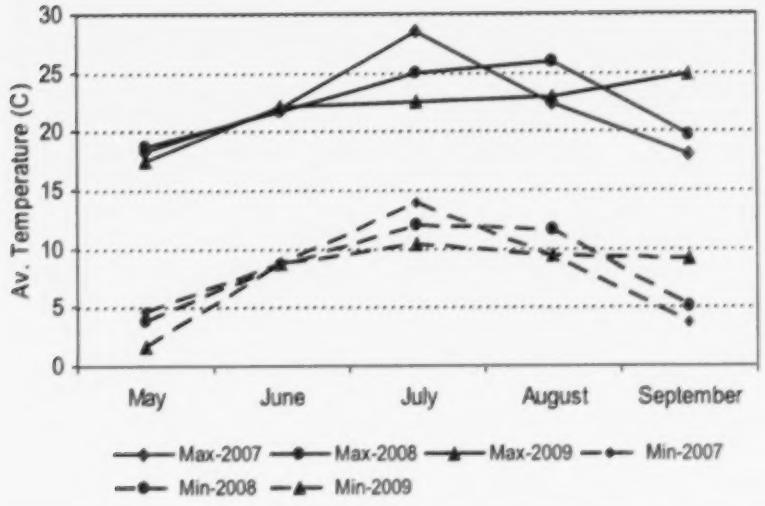


Figure 0-1. Average monthly maximum and minimum growing season temperature: 2007, 2008, 2009.

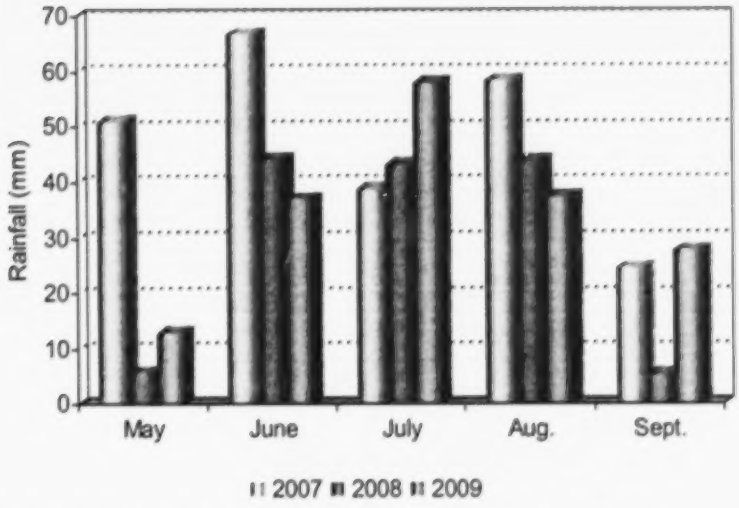


Figure 0-2. Total monthly rainfall during the growing: 2007, 2008, 2009.

Plate 0-1. Eptam application and discing.

Plate 0-2. Potato planting.

Plate 0-3. Hilling.

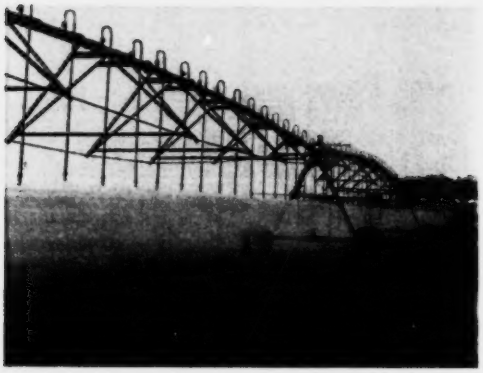


Plate 0-4. Irrigation.

Plate 0-5. Light measurement.

Plate 0-6. Pre-harvest desiccation.

Plate 0-7. Harvesting.

Plate 0-8. Potato grading.

Plate 0-9. Hail damage in potato.

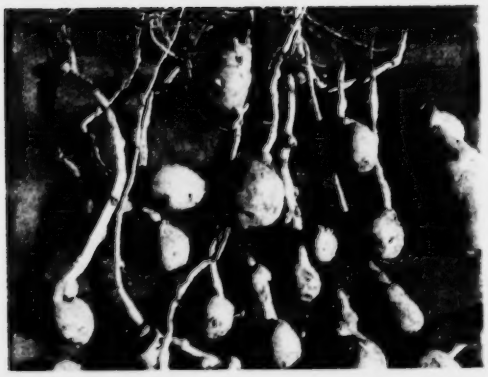


Plate 0-10. Heat stress potato tuber deformity.

Germplasm Screening:

Evaluation of Small Potato Clones/Cultivars for Irrigated production in Saskatchewan

BACKGROUND AND METHODOLOGY

Potato breeding programs in the world are traditionally designed for producing larger tubers targeted for the conventional table and processing markets. With growing demand for small potato, there is increasing interest among potato breeders from private and public institutions to develop cultivars suited for the small potato and the creamer potato markets. The emphasis is on producing higher tuber numbers and yield of small potatoes with the required market attributes.

This study (2007, 2008, 2009) evaluated several creamer clones developed at the Agriculture and Agri-Food Canada, Lethbridge Research Centre, and a few private small potato cultivars from private breeders. A few standard potato cultivars were also included in this study to examine their potential for the small potato market. The following clones were evaluated during the different years:

2007:
AAFC Creamer:
CV89023-2, CV96044-3, CV98243-1, CV99086-2, CV99161-5, V1118-2, V1241-1, VHB1159-1, WV3252-1
Commercial cultivar:
AC Peregrine, Alpha, Norland.

2008:
AAFC Creamer:
CV98243-1, VHB1159-1, CV96044-3, CV99161-5, V1118-2, WV3252-1, V1241-1, CV89023-2
Small potato:
Blushing Belle
Commercial cultivar:
AC Peregrine, Alpha, Norland

2009:
AAFC Creamer:
A90586-11, A90586, V96022-3, V97019-2, CV97065, V97123-1, CV97192-1, CV99073-1, CV99279-1, FV12246-6, FV12486-2
Small potato:
Operle

Field trials were established in Randomized Complete Block Design with four replications for each top-kill stage. Seed pieces were spaced 91 cm between-rows and 20 cm within the row. In 2007, the 10, 11, and 12 week top-killed crops received 96, 99, and 117 mm rain respectively. All three crops received 258 mm irrigation during the growing season. In 2008, the growing season received 98.4 mm rainfall and 160.0 mm irrigation. In 2009, the 10, 11, and 12 week top-kill crops received 97.2 mm, 107.6 mm, and 117.8 mm rainfall; and 178 mm, 210,

mm, and 244 mm irrigation respectively. The crops were flailed at 10, 11, and 12 weeks from planting and harvested after adequate skin-set.

RESULTS

Mainstem Count:

The mainstem numbers per hill for the creamer clones and commercial cultivars during 2007, 2008, and 2009 are summarized in Table 1-1.

The various clones and commercial cultivars produced variable stem numbers between years and among different harvest dates. As such, the range of mainstem numbers is given in Table 1-1. There were considerable differences in stem numbers between years (Table 1-1). In 2007, on average Norland, Alpha, CV99086-2, and V1118-2 produced higher stem numbers compared to the other entries. In 2008, Clones V1241-1 produced the highest stem count (3.4 - 4.3), whereas, CV89023-2 and CV99161-5 produced fewer mainstems (1.8 - 2.1). In 2009, Operle produced the highest number of mainstems (6.9 - 10.5) per hill while, all AAFC clones produced between three and five mainstems per hill.

Flowering:

Similar to mainstems, the days to first flower varied widely between years and among top-kill dates for the various entries. As such, the range for date to first flower is given in Table 1-2. Flowering was considerably late in 2008 compared to 2007 or 2009. Depending on the cultivars, days to first flower from planting ranged between 49 and 62 in 2007, 56 and 74 in 2008, and 52 to 72 in 2009.

The clone CV96044-3 flowered the earliest in all three years; i.e. 49 – 54 days in 2007, 56-58 days in 2008, and 52-53 days in 2009. Alpha was the latest flowering entry during the years this cultivar was tested. Among the clones tested in 2009, CV99279-1 was the latest flowering clone compared to the other clones.

Tuber Yield:

Yield of marketable and oversize tubers for the various clones and cultivars when flailed at 10, 11, and 12 weeks after planting during 2007, 2008, and 2009 are presented in Tables 1-3, 1-4, and 1-5; and Figures 1-1, 1-2, 1-3 respectively.

At the 10-week top-kill in 2007, The AAFC clone V1241-1 produced the highest marketable yields followed by CV96044-3 (Table 1-3). Norland and AC Peregrine produced over 7 t/ha marketable yield. Most entries averaged 6 to 8 t/ha marketable yield.

In 2008, the heat stress during tuberization caused considerable reduction in marketable yield. As in 2007, CV96044-3, V1241-1, and V1118-2 were the top yielders although the yields were only 6.7 t/ha, 5.7, and 5.6 t/ha for the two

respective clones (Table 1-4). Marketable yields for the other clones and cultivars averaged between two to four t/ha.

In 2009, during the 10 week top-kill, the small potato cultivar Operle produced 23.1 t/ha marketable yield which was 2.6-fold higher than the next highest yielding clone A90586-11 (Table 1-5).

Yield rankings were different for the various entries during the different flailing dates during 2007 (Table 1-3) and 2008 (Table 1-4). However in 2009 (Table 1-5), the yield rankings between the three top-kill dates were somewhat similar. For example Operle was the highest yielder and A90586-11, CV96044-3, and CV99279-1 the other top yielders during all harvest periods (Table 1-5).

Marketable tuber yields were generally similar between the 10, 11, and 12 week flailing periods during the three years indicating that delaying top-kill had no added advantage with respect to marketable yield. Marketable yields tended to drop when flailed at 12 weeks from planting.

Delaying flailing tended to increase oversize tuber yield during all three years (Tables 1-3, 1-4, 1-5, and Figures 1-1, 1-2, 1-3). The yield increases were variable between the different top-kill dates in the various years. In 2007, on average the 11-week flailing produced 59% higher yield than the 10-week flailing and the 12-week flailing produced 40% higher yield than the 11-week flailing (Table 1-3). The corresponding yield differences for the 11-week / 10-week flailing and 12-week / 11-week flailing were respectively 140% and 45% in 2008, and 64% and 28% in 2009.

With delay in flailing from 10 to 12 weeks from planting, the proportion of marketable size tubers decreased while the proportion of oversize tubers increased (Figures 1-4, 1-5, 1-6). The change in the proportions depended on the individual clones and the production year. For example, in 2009, there was minimal change in marketable yield between the three top-kill timings for the clone CV96044-3 and Operle indicating that these entries are better suited for small potato production and have stable marketable yields over a wide range of top-kill periods. By contrast some clones tended to continue rapid tuber bulking while negatively impacting the proportion of small marketable potato yields.

Table 1-1. Mainstem number for potato clones grown for the 'small potato' market: 2007 - 2009

Clone	Maintems per hill		
	2007	2008	2009
AC Peregrine	3.7 - 3.9	2.3 - 2.9	-
Alpha	5.2 - 5.9	2.3 - 3.0	-
Norland	5.5 - 7.1	2.9 - 3.1	-
CV89023-2	2.4 - 5.9	1.8 - 2.1	-
CV96044-3	3.2 – 5.1	3.3 - 3.6	2.9 - 4.0
CV9243-1	5.1	2.8 - 3.0	-
CV99086-2	5.4 - 6.1	-	-
CV99161-5	2.8 - 5.0	1.8 - 2.1	-
Blushing Belle	-	2.0 - 2.3	-
V1118-2	4.7 - 5.7	2.8 - 3.7	-
V1241-1	3.7 - 6.5	3.4 - 4.3	-
VHB1159-1	3.5 - 5.1	2.6 - 2.6	-
WV3252-1	4.1 - 4.5	2.6 - 3.3	-
A90586-11	-	-	2.7 - 4.1
CV96022-3	-	-	2.7 - 2.9
CV97019-2	-	-	2.3 - 3.1
CV97065-1	-	-	2.4 - 2.6
CV97123-1	-	-	2.8 - 3.1
CV97192-1	-	-	2.7 - 3.5
CV99073-1	-	-	2.9 - 4.2
CV99279-1	-	-	3.7 - 4.8
FV12246-6	-	-	2.7 - 3.0
FV12486-2	-	-	2.8 - 3.4
Operle	-	-	6.9 - 10.5

Table 1-2. Days to first flowering for potato clones grown for the 'small potato' market: 2007 - 2009

Clone	Days to first flower from planting		
	2007	2008	2009
AC Peregrine	54-59	64 - 66	-
Alpha	55-62	73 - 74	-
Norland	53-55	64	-
CV89023-2	58-61	68 - 72	-
CV96044-3	49-64	56 - 58	52 - 53
CV9243-1	51-58	60 - 61	-
CV99161-5	58-62	74 - 75	-
Blushing Belle	-	65 - 67	-
CV99086-2	58-62	-	-
V1118-2	51-57	60 - 61	-
V1241-1	54-57	60 - 61	-
VHB1159-1	56-61	64 - 69	-
WV3252-1	52-57	62 - 63	-
A90586-11	-	-	67
CV96022-3	-	-	59 - 61
CV97019-2	-	-	61 - 66
CV97065-1	-	-	59 - 60
CV97123-1	-	-	55 - 58
CV97192-1	-	-	54 - 55
CV99073-1	-	-	63 - 65
CV99279-1	-	-	69 - 72
FV12246-6	-	-	52 - 55
FV12486-2	-	-	61
Operle	-	-	55 - 57

Table 1-3. Yield of marketable and oversize tubers for creamer potato clones and selected commercial cultivars when flailed at 10, 11, and 12 weeks from planting: 2007

Clone / Cultivar	Marketable yield (t/ha)[z]			Oversize yield (t/ha)[y]		
	10 week flailing	11 week flailing	12 week flailing	10 week flailing	11 week flailing	12 week flailing
AC Peregrine	7.8	8.2	7.0	5.1	6.8	5.7
Alpha	5.9	9.1	6.7	0.9	1.6	12.9
Norland	7.3	6.1	7.2	15.7	19.5	17.4
CV89023-2	4.0	4.1	7.0	0.4	2.4	7.7
CV96044-3	9.7	10.0	5.5	7.0	9.3	4.3
CV98243-1	6.6	4.9	5.9	3.6	6.6	6.3
CV99086-2	0.2	1.2	8.0	0	0.03	8.9
CV99161-5	5.1	7.6	6.3	0.2	3.9	10.4
V1118-2	8.4	7.9	7.0	5.0	11.8	11.3
V1241-1	12.2	10.5	7.9	5.2	4.7	7.5
VHB1159-1	6.7	7.2	6.3	1.1	3.9	7.7
WV3252-1	8.9	8.5	4.2	2.5	3.8	3.5
ANOVA						
Source Cultivar	***(1.52)	***(1.91)	ns	***(3.08)	***(3.45)	ns
C.V. (%)	15.4	18.7	58.1	55	39	75.8

[z]Marketable grade includes tubers between 20-40 mm tuber diameter profile.

[y]Oversize grade includes tubers larger than 40 mm tuber diameter profile.

*** and ns indicate significance at P< 0.001 level of probability and not significant respectively. Values within parentheses are LSD estimates at 5.0% level of significance.

Table 1-4. Marketable and oversize tuber yields for potato clones and commercial cultivars top-killed at different ages: 2008

Clone	'Marketable tuber yield (t/ha)[Z]			Oversize tuber yield (t/ha)[Y]		
	10 week top-kill	11 week top-kill	12 week top-kill	10 week top-kill	11 week top-kill	12 week top-kill
AC Peregrine	3.4	4.3	3.2	0.9	8.9	12.7
Alpha	2.1	3.3	2.8	1.5	4.0	5.6
Norland	2.9	2.5	2.3	10.7	22.9	24.2
CV89023-2	2.4	4.5	4.1	1.3	7.5	14.0
CV96044-3	6.7	6.3	7.3	7.5	13.3	14.6
CV9243-1	3.2	2.5	2.5	5.4	13.0	20.6
CV99161-5	2.5	3.9	4.3	1.2	6.7	10.6
Blushing Belle	3.1	6.0	5.8	2.3	6.7	15.0
V1118-2	5.6	5.4	5.2	5.4	10.8	18.7
V1241-1	5.7	4.5	5.1	8.9	14.8	21.5
VHB1159-1	3.9	2.5	1.9	4.5	11.5	18.5
WV3252-1	4.4	5.8	4.3	4.9	10.5	13.7
ANOVA						
Source: Clone	***(1.7)	***(1.3)	*** (2.4)	***(3.0)	***(3.7)	***(5.8)
CV(%)	31.3	20.7	40.1	45.3	23.9	25.3

[Z]Marketable grade includes tubers between 20-40 mm tuber diameter profile.

[Y]Oversize grade includes tubers larger than 40 mm tuber diameter profile.

*** indicates significance at P<0.001 level of probability.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 1-5. Marketable and oversize tuber yields for potato clones and commercial cultivars top-killed at different ages: 2009

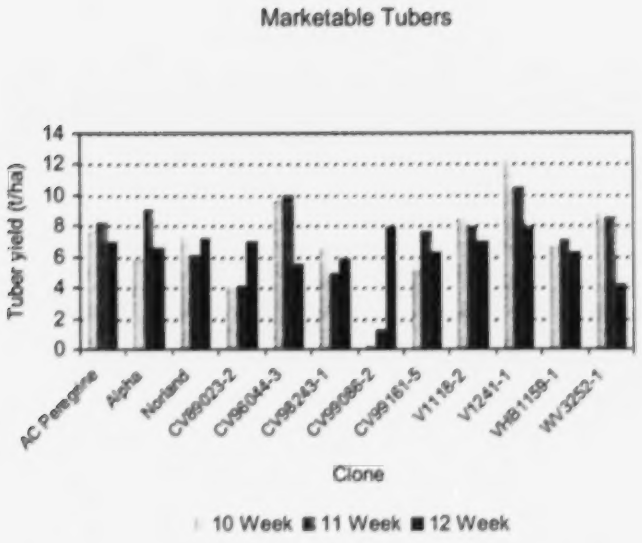
Clone	'Marketable tuber yield (t/ha)[z]			Oversize tuber yield (t/ha)[y]		
	10 week top-kill	11 week top-kill	12 week top-kill	10 week top-kill	11 week top-kill	12 week top-kill
A90586-11	8.9	10.4	6.3	6.4	12.5	14.0
CV96022-3	6.5	3.2	2.2	17.7	23.7	27.8
CV96044-3	8.1	8.5	8.0	7.4	14.0	18.8
CV97019-2	4.1	3.8	3.2	4.4	9.6	15.1
CV97065-1	3.9	3.3	3.6	9.1	18.6	23.6
CV97123-1	3.8	3.3	2.1	16.7	20.5	21.7
CV97192-1	3.2	3.0	1.8	13.0	18.4	23.3
CV99073-1	3.8	3.5	2.4	5.7	10.1	22.5
CV99279-1	7.1	8.3	5.0	1.9	9.1	11.1
FV12246-6	5.4	4.5	3.3	13.6	19.3	20.9
FV12486-2	5.7	4.2	2.6	10.9	21.6	22.5
Operle	23.1	26.2	25.2	7.8	10.9	17.5
ANOVA						
Source: Clone	***(2.8)	***(2.5)	*** (2.3)	***(3.2)	***(4.2)	***(7.5)
CV(%)	28.6	25.1	29.8	23.8	18.9	26.6

[z]Marketable grade includes tubers between 20-40 mm tuber diameter profile.

[y]Oversize grade includes tubers larger than 40 mm tuber diameter profile.

*** indicates significance at P<0.001 level of probability.

Values within parentheses are LSD estimates at 5.0% level of significance.



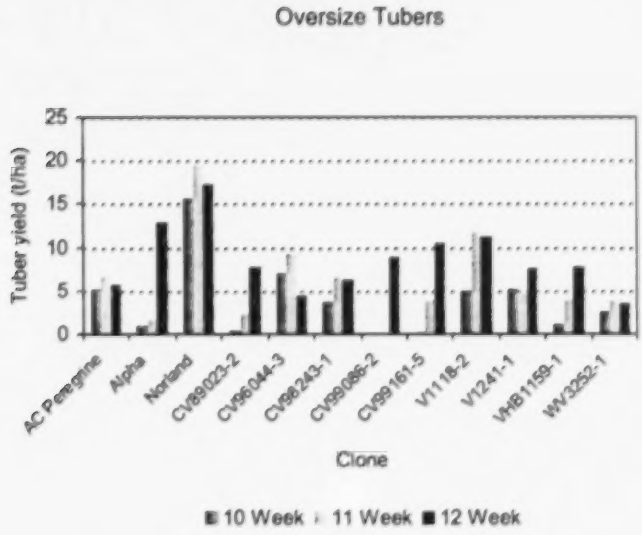
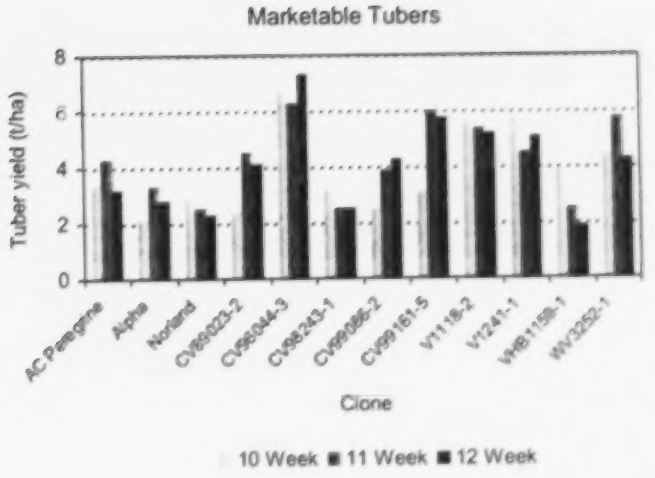


Figure 1-1. Marketable and Oversize tubers of potato clones and commercial cultivars when flailed at 10, 11, and 12 weeks from planting: 2007.



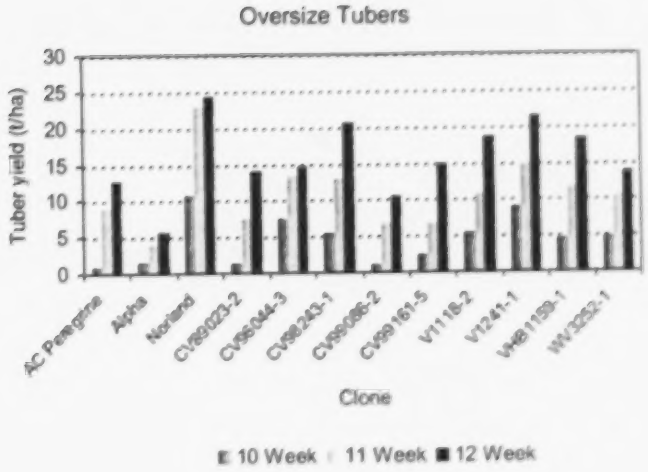
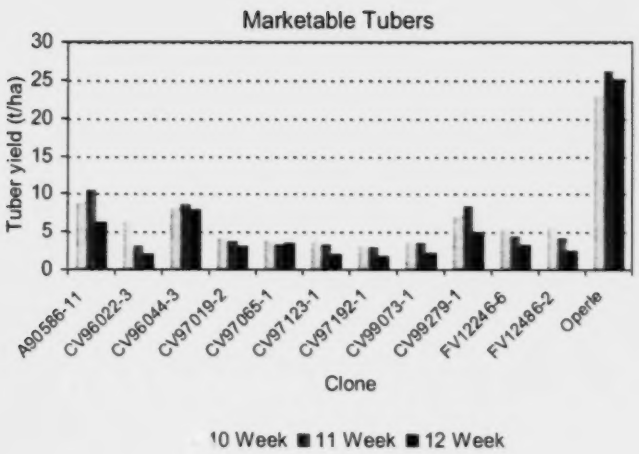


Figure 1-2. Marketable and Oversize tubers of potato clones and commercial cultivars when flailed at 10, 11, and 12 weeks from planting: 2008.



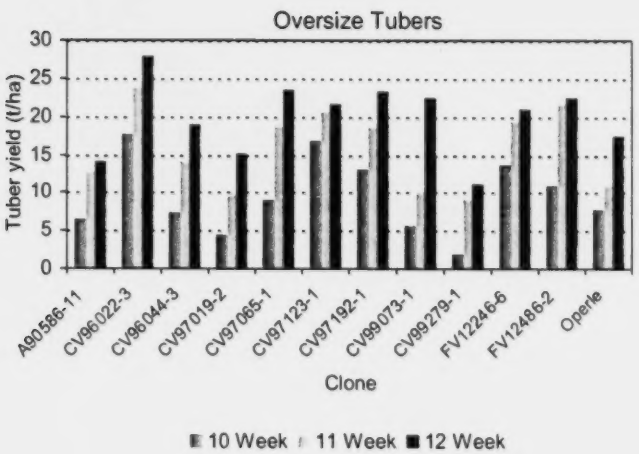


Figure 1-3. Marketable and Oversize tubers of potato clones and commercial cultivars when flailed at 10, 11, and 12 weeks from planting: 2009.

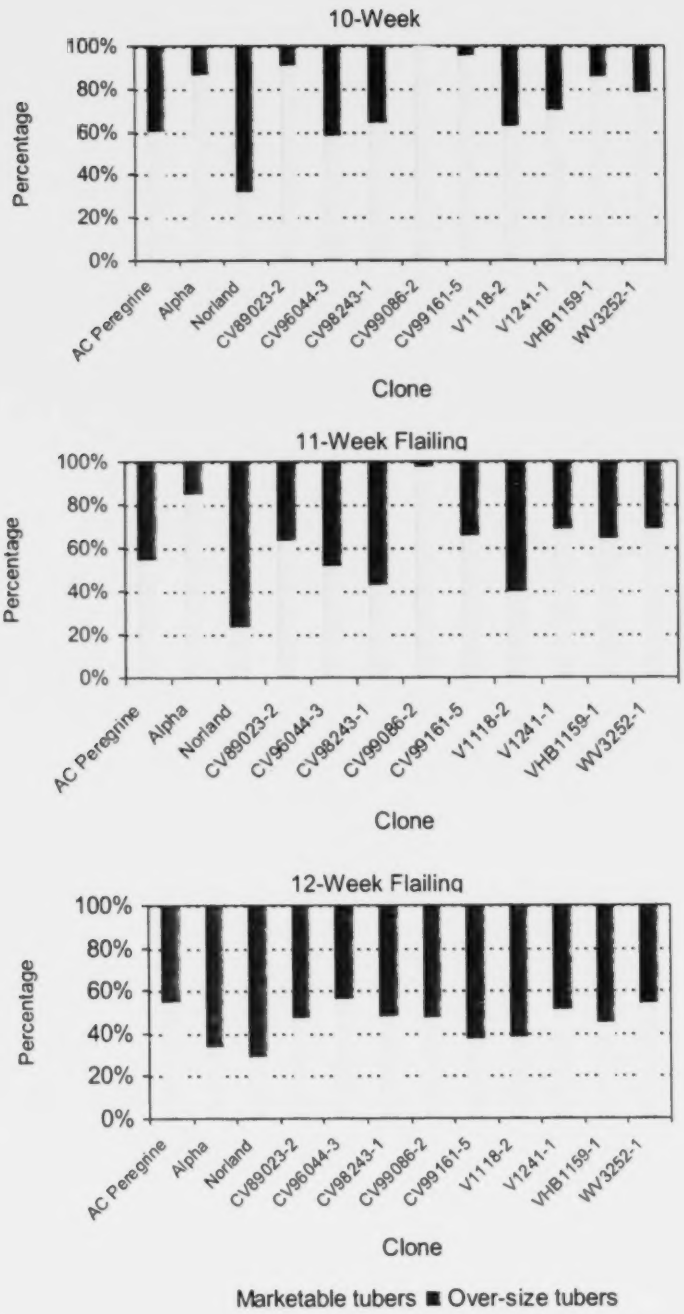


Figure 1-4. Proportion of marketable and oversize tubers for potato clones at 10, 11, and 12 week flailing periods: 2007.

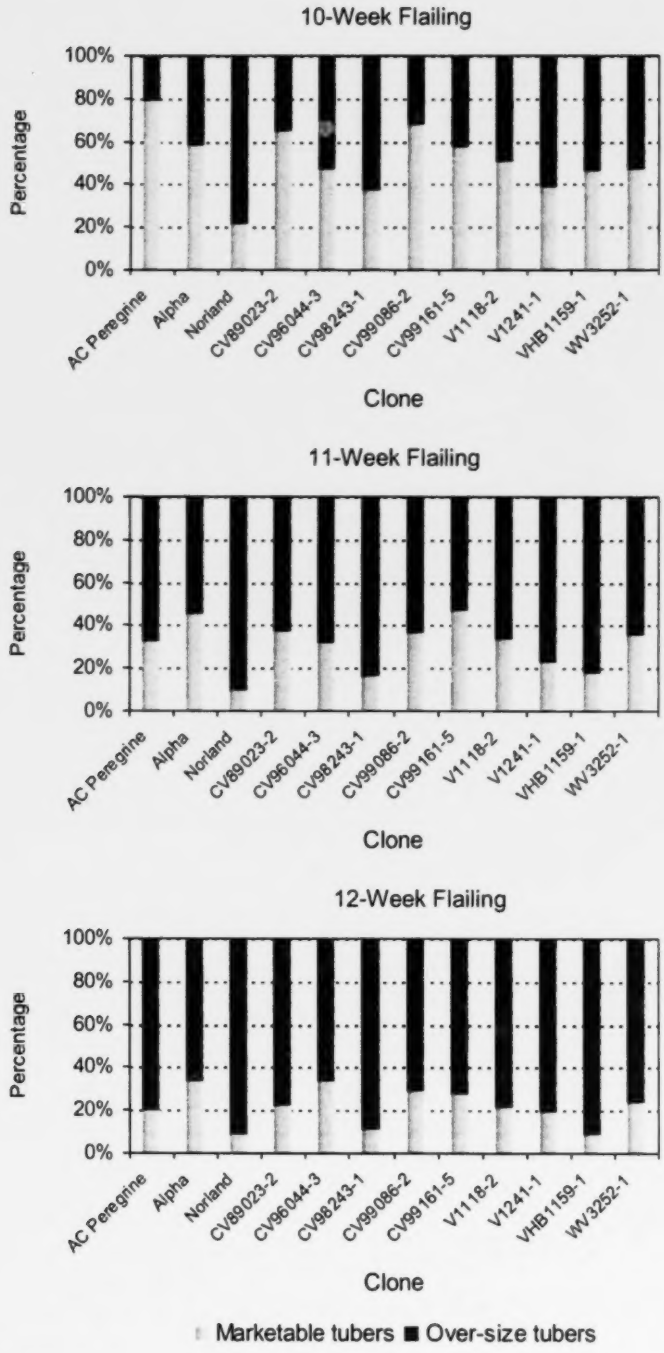


Figure 1-5. Proportion of marketable and oversize tubers for potato clones at 10, 11, and 12 week flailing periods: 2008.

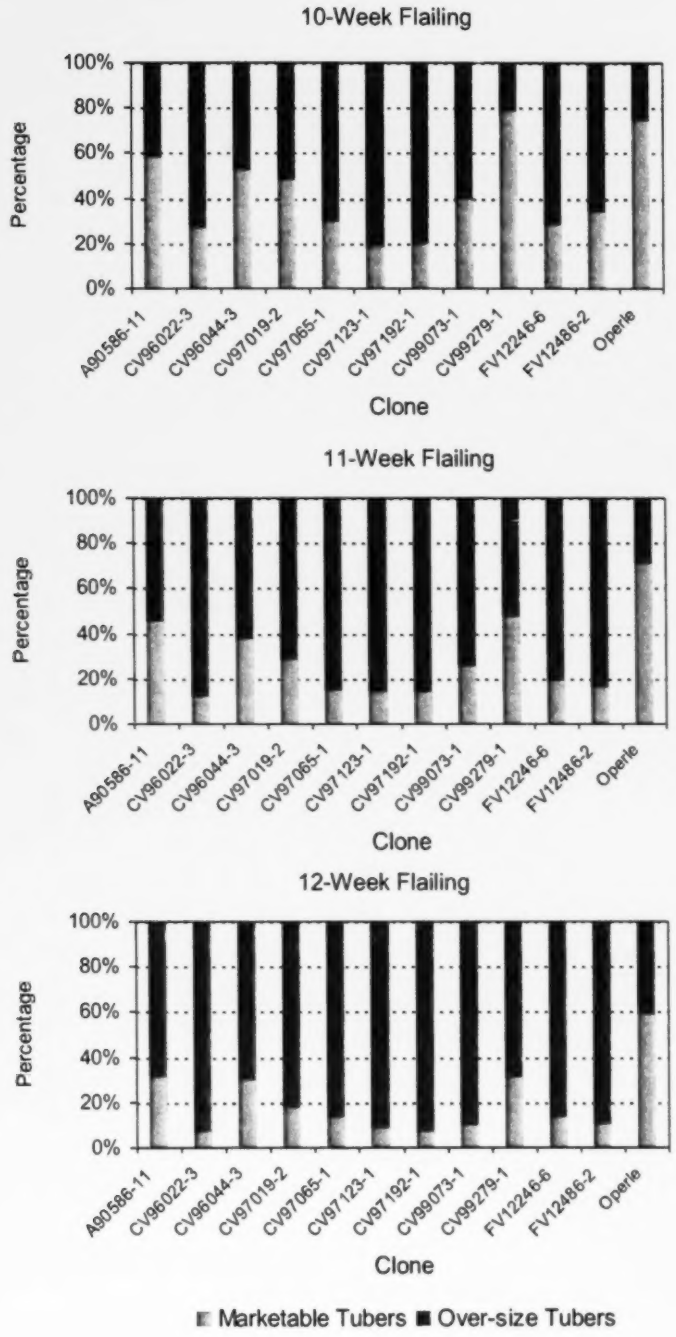


Figure 1-6. Proportion of marketable and oversize tubers for potato clones at 10, 11, and 12 week flailing periods: 2009.

Seed-Tuber Productivity:

Effect of Harvest Stage of Seed Crop on Growth and Productivity of Progeny for Small Potato Cultivars

BACKGROUND AND METHODOLOGY

Productive capacity of seed potato is influenced by the level of tuber-borne diseases and the physiological condition of the seed-tuber. The physiological condition of seed-tuber is dependant upon several factors including the environment under which the crop is grown and the cultural practices employed to produce the seed crop. Physiological age of the seed can be an important determinant on growth and productivity of the progeny.

This study was designed to examine the effect of the age of the seed crop on growth and yield attributes for several small potato and standard potato cultivars. Seed crops were grown in 2007 and 2008 and the performance of the progeny was evaluated in the following year.

2007 Seed Crop:
This study examined the interactive effects of the age of the seed crop and seed size on growth and yield for Baby Boomer, Piccolo, AC Peregrine, Norland, and Alpha potato. The seed crop was grown during the summer of 2007 and flailed at 10, 12, and 14 weeks after planting. The seed-tubers were stored under uniform conditions during the winter for testing in 2008. Growth and yield potential of two tuber size grades, i.e. 30-35 mm, 35-40 mm diameter, from the different seed age groups for the various cultivars were evaluated during the summer of 2008.

Field trials were laid out as 3 (Top-kill date) x 3 (Seed size) Factorial in a Randomized Complete Block Design with four replications for each cultivar.

2008 Seed Crop:
Seed of AC Peregrine, Norland, Blushing Belle, and the clone CV96044-3 were raised during the summer of 2008 and flailed at 10, 11, and 12 weeks after planting. The seed-tubers were stored under uniform conditions during the winter for testing in 2009. Growth and yield potential of one seed grade (35-40 mm diameter) from the different seed age groups for the various cultivars were evaluated during the summer of 2009.

Field trials were laid out as four (cultivars) x three (Top-kill date) Factorial in a Randomized Complete Block Design with four replications.

The 2008 and 2009 progeny evaluation trials were grown under irrigation with a 91 cm row spacing and 20 cm seed-piece spacing within the row. The 2008 growing season received 137 mm of rain and 258 mm of irrigation and the 2009 growing season received 108 mm rain and 213 mm irrigation.

RESULTS

The seed-tubers were stored under uniform conditions during the winter for testing in 2008.

Growth and yield attributes for the 2008 progeny evaluation trials are summarized in Tables 2-1 through 2-6 and the results from the 2009 trial is summarized in Table 2-7.

Emergence:
In 2008, top-kill date of the seed crop had no effect on the emergence of the progeny for Baby Boomer, AC Peregrine and Norland (Table 2-1). However for Alpha, seed from the 10 and 12-week top-killed seed crop emerged one day earlier than the seed from the 14 week top-kill seed crop. With Piccolo, it is not clear as to why the 12-week top-killed seed crop emerged three days later than the 10 or 14-week seed crop.

In 2009, the different cultivars emerged at different dates (Table 2-7). The clone CV96044-3 emerged the earliest (25 days from planting), and AC Peregrine the latest (32 days from planting). Seed from the 10 and 11-week top-killed seed crop emerged one day earlier than seed from the 12-week top-killed seed crop.

Mainstem Count:
In 2008, top-kill date of the seed crop had no effect on the number of mainstems produced by the progeny for Baby Boomer, Piccolo, Norland and Alpha potato (Table 2-2). However with AC Peregrine, the crop from 10-week top-killed seed produced fewer mainstems than 12-week or 14-week top-killed seed.

Larger Baby Boomer seed produced more mainstems than smaller seed (Table 2-2). Seed size had no effect on mainstem number for Piccolo, AC Peregrine, Norland, or Alpha.

In 2009, Norland and CV96044-3 produced more mainstems per hill (3.4, 3.6 respectively) than AC Peregrine or Blushing Belle (2.4, 2.8 respectively) (Table 2-7). Top-kill date had no effect on mainstem count.

Leaf Area Index (LAI):
Leaf Area Indices of the 2008 crops grown from the three different seed ages and the two seed sizes for the various cultivars at flowering and at flailing are summarized in Table 2-3 and Table 2-4 respectively. The interactive effects of seed crop age and cultivars on LAI at flowering and flailing during 2009 is summarized in Table 2-7.

In 2008, the top-kill date of the seed crop generally had no effect on LAI at flowering (Table 2-4) or at flailing (Table 2-5) for all cultivars. It is not clear why the 12-week top-killed Piccolo crop produced lower LAI than either the 10-week

or 14-week flailed crops. There were no identifiable biological trends with respect to the effects of seed size on LAI at flowering or at flailing for the various cultivars (Tables 2-3, 2-4)

In 2009, AC Peregrine produced higher LAI than the other cultivars during flowering, and all cultivars produced similar LAI at flailing (Table 2-7). Top-kill stage of the seed crop had no effect on LAI either at flowering or at flailing (Table 2-7).

Tuber Yield:

2008:

The effect of top kill dates on marketable tuber yield was variable for the different cultivars. For example, 14-week top-killed seed of Baby Boomer and Norland produced higher marketable yields than the crops from 10-week or 12-week top-killed seed (Table 2-5). Top-kill date of the seed crop had no effect on the productivity of Piccolo, AC Peregrine, or Alpha.

Larger Baby Boomer, Piccolo, and Norland seed produced higher marketable yield than smaller seed (Table 2-5). Seed size had no effect on marketable yield for AC Peregrine or Alpha.

The significant Top-kill date x Seed diameter interaction (Table 2-5) did not show any logical trends.

The effect of top kill dates on oversize tuber yield was variable for the different cultivars (Table 2-6). For AC Peregrine, the 12-week and 14-week top-killed seed crop produced higher oversize yields than the 10-week top-killed seed crop. The 14-week top-killed Norland seed crop produced higher oversize yields than the crop grown from the 10-week or 12-week seed crops. Seed crop age had no effect on oversize yield for Baby Boomer, Piccolo or Alpha.

Seed size had no effect on oversize yields for all cultivars except Norland where larger seed out-yielded smaller seed (Table 2-6).

2009:

Blushing Belle produced the highest marketable yields and the yield ranking were Blushing Belle>CV-99044-3>AC Peregrine>Norland. (Table 2-7). Time of top-kill of the seed crop had no effect on marketable yields.

Norland produced the highest oversize yields followed by CV99044-3, AC Peregrine, and Blushing Belle (Table 2-7). The progeny of the 10-week top-killed seed crop produced lower oversize yield than the 11-week and 12-week top-killed seed crop (Table 2-7). Seed from the 11-week and 12-week flailed seed crop produced similar oversize yield.

The relatively higher proportion of oversize yields relative to the marketable yields in this study indicates that better suited cultivars and more agronomic refinement are needed to maximize smaller-sized marketable yields for small potato production.

Table 2-1. Effects of top-kill timing of the seed crop and seed size on 50% emergence for selected potato cultivars: 2008

Treatment	50% emergence (Days from planting)				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	24	24	28	24	28
12 weeks	24	27	28	25	28
14 weeks	24	24	28	25	29
Seed-tuber diameter:					
30 – 35 mm	24	25	28	25	29
35 – 40 mm	24	25	28	24	29
ANOVA					
Source:					
Top-kill	ns	***(1)	ns	ns	***(1)
Seed diameter	ns	ns	ns	ns	ns
Top-kill x Seed diameter	ns	ns	ns	ns	ns
C.V. (%)	3.4	4.4	3.0	6.2	2.6

*** and ns indicate significance at P<0.001 level of probability and not significant respectively.
Values within parentheses are LSD estimates at 5.0% level of significance.

Table 2-2. Effects of top-kill timing of the seed crop and seed size on the number of mainstems per hill for selected potato cultivars: 2008

Treatment	Mainstem number per hill				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	3.4	2.4	1.7	2.5	2.0
12 weeks	3.3	2.3	2.1	2.8	2.1
14 weeks	3.4	2.3	2.1	2.7	2.4
Seed-tuber diameter:					
30 – 35 mm	3.1	2.3	1.9	2.6	2.1
35 – 40 mm	3.6	2.4	2.1	2.8	2.2
ANOVA					
Source:					
Top-kill	ns	ns	*(0.3)	ns	ns
Seed diameter	*(0.5)	ns	ns	ns	ns
Top-kill x Seed diameter	ns	ns	ns	ns	ns
C.V. (%)	15.9	13.4	14.4	14.5	15.5

* and ns indicate significance at P<0.05 level of probability and not significant respectively.
Values within parentheses are LSD estimates at 5.0% level of significance.

Table 2-3. Effects of top-kill timing of the seed crop and seed size on Leaf Area Index at flowering for selected potato cultivars: 2008

Treatment	Leaf Area Index				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	4.7	4.4	4.2	4.8	3.2
12 weeks	5.1	3.3	5.3	4.9	3.9
14 weeks	4.2	3.8	5.2	5.0	3.6
Seed-tuber diameter:					
30 – 35 mm	4.5	3.6	5.0	5.7	3.7
35 – 40 mm	4.9	4.1	4.9	4.2	3.5
ANOVA					
Source:					
Top-kill	ns	ns	ns	ns	ns
Seed diameter	ns	ns	ns	**(1.1)	ns
Top-kill x Seed diameter	ns	ns	ns	ns	ns
C.V. (%)	28.6	31.4	18.6	25.5	30.0

** and ns indicate significance at P<0.01 level of probability and not significant respectively.
Value within parenthesis is LSD estimate at 5.0% level of significance.

Table 2-4. Effects of top-kill timing of the seed crop and seed size on Leaf Area Index at flailing for selected potato cultivars: 2008

Treatment	Leaf Area Index				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	5.4	4.3	4.9	2.8	6.4
12 weeks	5.4	3.1	5.1	3.1	6.3
14 weeks	6.0	3.8	5.4	3.1	5.9
Seed-tuber diameter:					
30 – 35 mm	5.9	3.7	5.2	2.8	6.2
35 – 40 mm	5.3	3.7	5.0	3.2	6.1
ANOVA					
Source:					
Top-kill	ns	*(0.8)	ns	ns	ns
Seed diameter	ns	ns	ns	ns	ns
Top-kill x Seed diameter	ns	ns	ns	*(1.1)	ns
C.V. (%)	19.0	20.2	18.5	25.2	12.6

* and ns indicate significance at P<0.05 level of probability and not significant respectively.
Values within parentheses are LSD estimates at 5.0% level of significance.

Table 2-5. Effects of top-kill timing of the seed crop and seed size on marketable[z] tuber yield for selected potato cultivars: 2008

Treatment	Marketable tuber yield (t/ha)[z]				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	9.8	10.7	4.5	3.4	3.8
12 weeks	10.3	9.4	4.4	3.4	3.9
14 weeks	12.2	10.3	5.1	4.3	3.5
Seed-tuber diameter:					
30 – 35 mm	9.6	8.6	4.8	3.4	3.4
35 – 40 mm	11.9	11.7	4.6	4.0	4.1
ANOVA					
Source:					
Top-kill	*(1.9)	ns	ns	**(0.5)	ns
Seed diameter	**(1.5)	***(2.4)	ns	**(0.6)	ns
Top-kill x Seed diameter	na	na	ns	*(0.9)	ns
C.V. (%)	16.4	13.8	28.0	15.9	21.2

[z]Marketable grade includes tubers between 20-40 mm tuber diameter profile.

***, **, * and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 2-6. Effects of top-kill timing of the seed crop and seed size on Oversize[z] tuber yield for selected potato cultivars: 2008

Treatment	Oversize tuber yield (t/ha)[z]				
	Baby Boomer	Piccolo	AC Peregrine	Norland	Alpha
Top-kill timing of seed crop:					
10 weeks	3.5	4.6	6.2	10.6	4.5
12 weeks	3.5	2.8	9.4	10.0	4.5
14 weeks	4.0	5.0	9.1	13.1	4.7
Seed-tuber diameter:					
30 – 35 mm	3.1	3.8	7.9	10.5	4.2
35 – 40 mm	4.2	4.8	8.6	12.0	5.0
ANOVA					
Source:					
Top-kill	ns	ns	**(2.1)	**(1.9)	ns
Seed diameter	ns	ns	ns	*(1.5)	ns
Top-kill x Seed diameter	ns	ns	ns	ns	ns
C.V. (%)	39.1	54.2	23.8	15.5	23.6

[z]Oversize grade includes tubers larger than 40 mm tuber diameter profile.

**, * and ns indicate significance at P<0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 2-7. Effects of top-kill timing of the seed crop on growth and yield attributes for selected potato cultivars: 2009

Treatment	50% Emergence DAP	Mainstems/hill	LAI at Flower	LAI at Flail	Marketable[Z] Yield (t/ha)	Oversize[Y] Yield (t/ha)
Cultivar:						
AC Peregrine	32	2.4	4.4	3.0	5.4	13.7
CV-96044-3	25	3.6	2.8	3.2	7.2	17.3
Blushing Belle	29	2.8	2.5	3.2	13.1	12.6
Norland	30	3.4	2.6	2.9	3.9	24.4
Top-kill timing of seed crop:						
10 weeks	29	2.8	2.5	3.0	6.9	14.7
11 weeks	29	3.1	3.6	3.0	7.5	18.4
12 weeks	30	3.2	3.2	3.3	7.9	17.9
ANOVA						
Source:						
Top-kill	***(0.9)	***(0.5)	**(1.0)	ns	***(1.3)	***(3.2)
Cultivar	**(0.8)	ns	ns	ns	ns	*(2.8)
Top-kill x Cultivar	ns	ns	ns	ns	ns	ns
C.V. (%)	3.9	17.8	40.7	27.3	20.8	22.6

[Z]Marketable grade includes tubers between 20-40 mm tuber diameter profile.

[Y]Oversize grade includes tubers larger than 40 mm tuber diameter profile.

***, **, * and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.
Values within parentheses are LSD estimates at 5.0% level of significance.

Fertility Management:

Effects of Rate and Timing of Nitrogen Application and Seed-piece Spacing on Yield Attributes for Contrasting Cultivars

BACKGROUND AND METHODOLOGY

Potato is a heavy user of nutrients. Fertilizer requirement can be affected by several factors including genotype, growth habit, maturity characteristics, production environment (climatic condition and length of growing season) and harvest timing. The quantity of fertilizer and timing of application is critical to maximize tuber yields and improve quality, particularly under Saskatchewan's relatively cool and short growing seasons.

Small potato production requires early top-kill compared to conventional potato crops. For small potato, the stage of top-kill can occur relatively early in the crop growth cycle, i.e. before reaching maturity. Therefore, it is likely that fertilizer recommendations used for standard potato production may not be suitable for 'small' potato production.

This study, conducted 2007 through 2009, was designed to examine the effects of rate and timing of nitrogen application, and seed spacing on growth and yield productivity for contrasting potato cultivars. This included specific small potato cultivars and standard table potato cultivars with potential for producing small potato.

Cultivars tested in 2007 and 2008:

Small potato cultivars: Baby Boomer, Blushing Belle, Piccolo
Table potato cultivars: AC Peregrine, Alpha

Cultivars tested in 2009:

Small potato cultivars: Baby Boomer, Blushing Belle, Piccolo
Table potato cultivars: AC Peregrine, Norland

Three nitrogen rates (200, 300, 400 kg N/ha), two nitrogen application timing (all at planting, Two-splits, i.e. half at planting and half at 2nd hilling); and two seed-piece spacings (15, 20 cm) were evaluated. Phosphorus 120 kg P_2O_5/ha and potassium 100 kg K_2O/ha were applied at planting. Field plots were laid out in a Split-split-plot design (Main-plot: Seed spacing, Sub-plot: Nitrogen rate, Sub-sub-plot: Nitrogen timing) with four replications. Separate tests were carried out for each cultivar.

The crop was planted in 91 cm rows with seed-piece spacing at 15 cm or 20 cm as determined by the treatments. The 2007 crop received 200 mm rainfall and 160 mm of irrigation; the 2008 crop received 135 mm of rainfall and 258 mm of irrigation; and 2009 crop received 134 mm rainfall and 280 mm of irrigation.

RESULTS AND DISCUSSION

Flowering:
The analyses of variance information and the treatment averages of days to first flower as influenced by nitrogen rate, nitrogen timing, and seed spacing are summarized in Table 3-1 and Table 3-2 respectively.

The date to first flower was variable for the cultivars in the different years. For Baby Boomer, first flowering occurred at 56-58 days in 2007, 62-64 days in 2008, and 64 days in 2009. For Piccolo, first flowering occurred at 61-62 days in 2007, 66 days in 2008, and 69 days in 2009. For Blushing Belle, first flowering occurred at 59-60 days in 2007, 66-67 days in 2008, and 68-69 days in 2009. For AC Peregrine first flowering occurred at 56 days in 2007, 64-65 days in 2008, and 66-67 days in 2009. For Alpha, first flowering occurred at 62-63 days in 2007, and 74 days in 2008. Norland flowered at 63 days in2009.

Seed spacing, nitrogen rate or timing of nitrogen application had no effect on first flowering for all cultivars in the three study years with some exceptions in 2007 and 2008 (Table 3-1). In 2007 with Blushing Belle, wider spacing and split application of nitrogen delayed flowering by one day relative to closer spacing and nitrogen applied all at planting (Table 3-2). In 2008, higher nitrogen rates delayed flowering of Baby Boomer by one day relative to lower nitrogen rates.

Leaf Area Index (LAI):
The 2008 and 2009 analyses of variance information and the treatment averages of Leaf Area Indices at first flower as influenced by nitrogen rate, nitrogen timing, and seed spacing are summarized in Table 3-3 and Table 3-4 respectively. The corresponding information on LAI at flailing during 2007, 2008, and 2009 are summarized in Table 3-5 and Table 3-6 respectively.

LAI at Flowering:
In 2008, LAI at flowering averaged 4.1, 3.7, 2.8, 4.7, and 4.6 for Baby Boomer, Piccolo, Blushing Belle, AC Peregrine and Alpha respectively (Table 3-4). In 2009, LAI at flowering averaged 2.9, 2.2, 2.2, 3.7, and 2.1 for Baby Boomer, Piccolo, Blushing Belle, AC Peregrine and Norland respectively (Table 3-4).

Nitrogen rate generally had no effect on LAI at flowering for all cultivars except Blushing Belle in 2008 and Piccolo in 2009 (Table 3-3). In 2008, with Blushing Belle, the highest rate of nitrogen (400 kg N/ha) resulted in lower LAI than 300 kg N/ha (Table 3-4). Contrastingly in 2009, Piccolo produced the lowest LAI at 300 kg N/ha compared to 200 kg N/ha and 400 kg N/ha. It is possible that the latter response is due to experimental error.

Timing of N application, i.e. all at planting or split application (half at plant and half at second hilling) had no effect on LAI at flowering for all cultivars during both 2008 and 2009 (Table 3-3).

In 2008, seed spacing had no effect on LAI at flowering for Baby Boomer, Piccolo, AC Peregrine, or Alpha and all for cultivars in 2009 (Table 3-3). However in 2008, Blushing Belle produced higher LAI at 20 cm seed spacing than 15 cm seed piece spacing, whereas, Alpha produced higher LAI at 15 cm seed spacing than 20 cm seed spacing (Table 3-4).

LAI at Flailing:
In 2007, LAI at flailing averaged 3.8, 2.6, 3.7, 4.4, and 3.3 for Baby Boomer, Piccolo, Blushing Belle, AC Peregrine and Alpha respectively (Table 3-6). In 2008, LAI at flailing averaged 4.7, 4.4, 4.8, 5.7, and 5.5 for the respective cultivars. In 2009, LAI at flailing averaged 2.9, 2.8, 2.2, 4.8, and 3.2 Baby Boomer, Piccolo, Blushing Belle, AC Peregrine and Norland respectively (Table 3-6).

The relatively high LAI's at flailing is an indication that the plants are still actively growing at the time of harvest.

Generally seed spacing, nitrogen rate, and nitrogen timing had no effect days to flowering for the various cultivars with the following exceptions (Table 3-1, Table 3-20):
For Blushing Belle in 2007:

> Closer spacing and split-application of nitrogen flowered one day earlier than wider spacing and one-time application of nitrogen.

For Baby Boomer in 2008:

> 200 kg N/ha nitrogen application flowered one day earlier than the 400 kg N/ha and two days earlier than 300 kg N/ha nitrogen application. It is not clear the 400 kg N/ha application flowered one earlier than the 300 kg N/ha application.

Tuber Yield:
Marketable Yield:
The 2007 to 2009 analyses of variance information and the treatment averages of marketable tuber yield as influenced by nitrogen rate, nitrogen timing, and seed spacing are summarized in Table 3-7 and Table 3-8 respectively. Tuber yields were relatively low in 2007 compared to 2008 and 2009. This is likely due to warmer temperatures during tuberization during 2007 relative to 2008 or 2009 (Figure 0-1).

The ranking of marketable yields for the different cultivars were variable among different years (Table 3-8). In 2007, marketable tuber yields averaged at 1.7 t/ha for Alpha, 2.5 t/ha for Blushing Belle, 2.7 t/ha for Baby Boomer, and 4.9 t/ha for AC Peregrine and Piccolo. In 2008, marketable yields averaged 4.6 t/ha for Alpha, 5.8 t/ha for AC Peregrine, 9.8 t/ha for Blushing Belle, 11.8 t/ha for Baby

Boomer, and 16.8 t/ha for Piccolo. In 2009, marketable yields averaged 4.1 t/ha for Norland, 5.9 t/ha for AC Peregrine, 10.5 t/ha for Blushing Belle, 18.3 t/ha for Piccolo, and 18.9 t/ha for Baby Boomer.

Higher rate of nitrogen produced lower marketable yields than lower rate of nitrogen for all cultivars in 2007 and for AC Peregrine in 2009 (Table 3-7, Table 3-8). Nitrogen rate had no effect on marketable yields for all the cultivars in 2008, and all but AC Peregrine in 2009.

Split application of nitrogen produced higher marketable yields for Piccolo, AC Peregrine and Alpha compared to single application in 2007. Timing of nitrogen had no effect on marketable yields for Baby Boomer and Blushing Belle in 2007 and all the cultivars in 2008 and 2009 (Table 3-7, Table 3-8).

The 15 cm seed-piece spacing produced higher marketable tuber yields than 20 cm spacing and the differences reached significant proportions for Baby Boomer in 2007, Piccolo and Blushing Belle in 2008 and Piccolo, Blushing Belle and Norland in 2009.

Oversize Yield:
The results of analyses of variance and average oversize yields in relation to the effects of seed spacing, nitrogen rate, and timing of nitrogen application for the various cultivars in 2007, 2008, and 2009 are summarized in Table 3-9 and Table 3-10 respectively.

In 2007 and 2009, generally, higher nitrogen rates produced lower oversize yields than lower nitrogen rates. The effects reached significant proportions for Piccolo and Blushing Belle in 2007 and Baby Boomer and AC Peregrine in 2009. Nitrogen rate had no effect on oversize yields in 2008.

Nitrogen timing had no effect of oversize tuber yield except for AC Peregrine and Alpha in 2008 where split application produced higher oversize yield than single application (Table 3-9, Table 3-10).

Seed spacing had no effect of oversize tuber yield except for AC Peregrine and Alpha in 2008 where 15 cm seed spacing produced higher oversize yield than the 20 cm spacing (Table 3-9, Table 3-10).

Table 3-1. Analyses of variance results on the effects of seed-piece spacing, nitrogen rate, and nitrogen timing effects on days to flowering for selected potato cultivars: 2007 - 2009

Source	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2007			
Spacing (S)	ns	ns	*(0.7)	ns	ns	-
Nitrogen rate (R)	ns	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	*(0.7)	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	*(1.1)	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2008			
Spacing (S)	ns	ns	ns	ns	ns	-
Nitrogen rate (R)	*(1.0)	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2009			
Spacing (S)	ns	ns	ns	ns	-	ns
Nitrogen rate (R)	ns	ns	ns	ns	-	ns
Nitrogen timing (T)	ns	ns	ns	ns	-	ns
S x R	ns	ns	ns	ns	-	ns
S x T	ns	ns	ns	ns	-	ns
R x T	ns	ns	ns	ns	-	ns
S x R x T	ns	ns	ns	ns	-	ns

* and ns indicate significance at P<0.05 level of probability and not significant respectively.
Values within parentheses are LSD estimate at 5.0% level of significance.

Table 3-2. Seed-piece spacing, nitrogen rate, and timing effects on days to flower for selected potato cultivars: 2007 - 2009

Treatment	Days to flower					
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2007			
Seed piece spacing :						
15 cm	56 a	62 a	59 a	56 a	63 a	-
20 cm	57 a	61 a	60 b	56 a	63 a	-
Nitrogen rate:						
200 kg N/ha	56 a	61 a	60 a	56 a	62 a	-
300 kg N/ha	57 a	61 a	60 a	56 a	63 a	-
400 kg N/ha	58 a	62 a	60 a	56 a	63 a	-
Nitrogen timing:						
All @ planting	57 a	61 a	60 b	56 a	63 a	-
½ @ planting + ½ @ hilling	57 a	61 a	59 a	56 a	63 a	-
			2008			
Seed piece spacing :						
15 cm	63 a	66 a	67 a	64 a	74 a	-
20 cm	63 a	66 a	67 a	65 a	74 a	-
Nitrogen rate:						
200 kg N/ha	62 a	66 a	66 a	64 a	74 a	-
300 kg N/ha	64 c	66 a	67 a	65 a	74 a	-
400 kg N/ha	63 b	66 a	67 a	65 a	74 a	-
Nitrogen timing:						
All @ planting	63 a	66 a	67 a	65 a	74 a	-
½ @ planting + ½ @ hilling	63 a	66 a	67 a	64 a	74 a	-
			2009			
Seed piece spacing :						
15 cm	64 a	69 a	69 a	66 a	-	63 a
20 cm	64 a	69 a	68 a	67 a	-	63 a
Nitrogen rate:						
200 kg N/ha	64 a	69 a	68 a	66 a	-	63 a
300 kg N/ha	64 a	69 a	68 a	66 a	-	63 a
400 kg N/ha	64 a	69 a	69 a	67 a	-	63 a
Nitrogen timing:						
All @ planting	64 a	69 a	69 a	67 a	-	63 a
½ @ planting + ½ @ hilling	64 a	69 a	68 a	66 a	-	63 a

Within each factor, values followed by same letter are not significantly different at $P<0.05$ level of probability.

Table 3-3. Analyses of variance results on the effects of seed-piece spacing, nitrogen rate, and nitrogen timing effects on Leaf Area Index at first flower for selected potato cultivars: 2008 and 2009

Source	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2008			
Spacing (S)	ns	ns	**(0.4)	ns	*(0.9)	-
Nitrogen rate (R)	ns	ns	*(0.5)	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2009			
Spacing (S)	ns	ns	ns	ns	-	ns
Nitrogen rate (R)	ns	*(0.4)	ns	ns	-	ns
Nitrogen timing (T)	ns	ns	ns	ns	-	ns
S x R	ns	ns	ns	ns	-	ns
S x T	ns	ns	ns	ns	-	ns
R x T	ns	ns	ns	ns	-	ns
S x R x T	ns	ns	ns	ns	-	ns
					-	

**, * and ns indicate significance at P<0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimate at 5.0% level of significance.

Table 3-4. Seed-piece spacing, nitrogen rate, and timing effects on Leaf Area Index at first flower for selected potato cultivars: 2008 and 2009

Treatment	Leaf Area Index					
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2008			
Seed piece spacing :						
15 cm	4.3 a	3.7 a	2.4 a	4.7 a	5.0 b	-
20 cm	3.9 a	3.6 a	3.2 b	4.7 a	4.1 a	-
Nitrogen rate:						
200 kg N/ha	4.6 a	3.7 a	2.7 ab	4.6 a	4.6 a	-
300 kg N/ha	3.7 a	3.4 a	3.1 b	4.9 a	4.7 a	-
400 kg N/ha	4.0 a	3.9 a	2.5 a	4.5 a	4.3 a	-
Nitrogen timing:						
All @ planting	4.1 a	3.8 a	2.8 a	4.8 a	4.4 a	-
½ @ planting + ½ @ hilling	4.1 a	3.6 a	2.8 a	4.6 a	4.6 a	-
			2009			
Seed piece spacing :						
15 cm	3.2 a	2.1 a	2.2 a	3.8 a	-	2.0 a
20 cm	2.7 a	2.1 a	2.2 a	3.5 a	-	2.2 a
Nitrogen rate:						
200 kg N/ha	2.8 a	2.2 b	2.4 a	3.3 a	-	2.3 a
300 kg N/ha	3.0 a	1.8 a	2.1 a	3.8 a	-	2.0 a
400 kg N/ha	3.0 a	2.4 b	2.1 a	3.9 a	-	2.1 a
Nitrogen timing:						
All @ planting	2.9 a	2.2 a	2.1 a	3.7 a	-	2.0 a
½ @ planting + ½ @ hilling	2.9 a	2.1 a	2.3 a	3.6 a	-	2.2 a

Within each factor, values followed by same letter are not significantly different at $P<0.05$ level of probability.

Table 3-5. Analyses of variance results on the effects of seed-piece spacing, nitrogen rate, and nitrogen timing effects on Leaf Area Index at flail for selected potato cultivars: 2007 - 2009

Source	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2007			
Spacing (S)	ns	ns	ns	ns	ns	-
Nitrogen rate (R)	ns	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	*(0.6)	-
S x R x T	ns	ns	ns	ns	ns	-
			2008			
Spacing (S)	ns	ns	ns	ns	ns	-
Nitrogen rate (R)	ns	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2009			
Spacing (S)	ns	ns	ns	ns	-	ns
Nitrogen rate (R)	ns	ns	ns	ns	-	ns
Nitrogen timing (T)	ns	ns	ns	ns	-	ns
S x R	ns	ns	ns	ns	-	ns
S x T	ns	ns	ns	ns	-	ns
R x T	ns	ns	ns	ns	-	ns
S x R x T	ns	ns	ns	ns	-	ns

* and ns indicates significance at $P<0.05$ level of probability and not significant respectively.
Value within parenthesis is LSD estimate at 5.0% level of significance.

Table 3-6. Seed-piece spacing, nitrogen rate, and timing effects on Leaf Area Index at flail for selected potato cultivars: 2007 - 2009

Treatment	Leaf Area Index					
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
2007						
Seed piece spacing :						
15 cm	3.8 a	2.6 a	4.0 a	4.4 a	3.5 a	-
20 cm	3.7 a	2.6 a	3.7 a	4.5 a	3.1 a	-
Nitrogen rate:						
200 kg N/ha	3.8 a	2.6 a	4.0 a	4.3 a	3.3 a	-
300 kg N/ha	4.0 a	2.4 a	3.9 a	4.4 a	3.2 a	-
400 kg N/ha	3.5 a	2.8 a	3.7 a	4.6 a	3.4 a	-
Nitrogen timing:						
All @ planting	3.9 a	2.5 a	3.9 a	4.6 a	3.3 a	-
½ @ planting + ½ @ hilling	3.6 a	2.7 a	3.8 a	4.2 a	3.3 a	-
2008						
Seed piece spacing :						
15 cm	4.5 a	4.3 a	4.8 a	5.9 a	5.4 a	-
20 cm	4.8 a	4.4 a	4.8 a	5.5 a	5.6 a	-
Nitrogen rate:						
200 kg N/ha	4.5 a	4.4 a	4.5 a	5.5 a	5.4 a	-
300 kg N/ha	4.8 a	4.1 a	5.3 a	5.8 a	5.6 a	-
400 kg N/ha	4.8 a	4.5 a	4.5 a	5.8 a	5.5 a	-
Nitrogen timing:						
All @ planting	4.8 a	4.5 a	4.6 a	5.7 a	5.3 a	-
½ @ planting + ½ @ hilling	4.5 a	4.2 a	5.0 a	5.7 a	5.7 a	-
2009						
Seed piece spacing :						
15 cm	2.8 a	2.8 a	2.0 a	4.9 a	-	3.3 a
20 cm	2.9 a	2.6 a	2.4 a	4.6 a	-	3.0 a
Nitrogen rate:						
200 kg N/ha	2.6 a	2.9 a	2.1 a	4.5 a	-	3.3 a
300 kg N/ha	3.1 a	2.6 a	2.3 a	4.9 a	-	3.2 a
400 kg N/ha	2.9 a	2.7 a	2.1 a	4.7 a	-	3.0 a
Nitrogen timing:						
All @ planting	2.9 a	2.6 a	2.2 a	5.0 a	-	3.3 a
½ @ planting + ½ @ hilling	2.8 a	2.9 a	2.2 a	4.5 a	-	3.0 a

Within each factor, values followed by same letter are not significantly different at P<0.05 level of probability.

Table 3-7. Analyses of variance results on the effects of seed-piece spacing, nitrogen rate, and nitrogen timing effects on marketable[z] yield for selected potato cultivars: 2007 - 2009

Source	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2007			
Spacing (S)	**0.5)	ns	ns	ns	ns	-
Nitrogen rate (R)	**(0.8)	**(0.9)	**(0.7)	**(0.7)	**(0.7)	-
Nitrogen timing (T)	ns	**(0.6)	ns	**(0.6)	**(0.5)	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2008			
Spacing (S)	ns	*(1.2)	**(0.8)	ns	ns	-
Nitrogen rate (R)	ns	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	*(1.2)	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2009			
Spacing (S)	ns	*(3.0)	*(2.1)	ns	-	*(0.4)
Nitrogen rate (R)	ns	ns	ns	*(0.2)	-	ns
Nitrogen timing (T)	ns	ns	ns	ns	-	ns
S x R	ns	ns	ns	ns	-	ns
S x T	ns	ns	ns	ns	-	ns
R x T	ns	ns	ns	ns	-	ns
S x R x T	ns	ns	ns	ns	-	ns

[z]Marketable grade includes tubers between 20-40 mm diameter profile.

**, * and ns indicate significance at P<0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimate at 5.0% level of significance.

Table 3-8. Seed-piece spacing, nitrogen rate and timing effects on marketable tuber yield for selected potato cultivars: 2007 - 2009

Treatment	Marketable tuber yield (t/ha)[z]					
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
2007						
Seed piece spacing :						
15 cm	3.1 b	5.3 a	2.7 a	5.4 a	1.7 a	-
20 cm	2.3 a	4.6 a	2.4 a	4.4 a	1.6 a	-
Nitrogen rate:						
200 kg N/ha	4.0 c	6.2 c	3.7 b	5.9 b	2.3 b	-
300 kg N/ha	2.6 b	4.6 b	2.1 a	4.6 a	1.5 a	-
400 kg N/ha	1.3 a	3.9 a	1.8 a	4.2 a	1.1 a	-
Nitrogen timing:						
All @ planting	2.6 a	4.3 a	2.5 a	4.6 a	1.3 a	-
½ @ planting + ½ @ hilling	2.7 a	5.6 b	2.6 a	5.2 b	2.0 b	-
2008						
Seed piece spacing :						
15 cm	12.4 a	17.6 b	10.6 b	6.0 a	5.0 a	-
20 cm	11.2 a	15.9 a	8.9 a	5.7 a	4.4 a	-
Nitrogen rate:						
200 kg N/ha	11.9 a	17.0 a	10.2 a	5.5 a	4.8 a	-
300 kg N/ha	11.6 a	17.1 a	10.1 a	6.1 a	4.9 a	-
400 kg N/ha	11.9 a	16.2 a	9.0 a	5.8 a	4.3 a	-
Nitrogen timing:						
All @ planting	12.1 a	16.9 a	9.5 a	5.9 a	4.4 a	-
½ @ planting + ½ @ hilling	11.5 a	16.6 a	10.0 a	5.7 a	5.0 a	-
2009						
Seed piece spacing :						
15 cm	19.0 a	19.9 b	12.0 b	6.1 a	-	4.6 b
20 cm	19.0 a	16.6 a	8.9 a	5.7 a	-	3.5 a
Nitrogen rate:						
200 kg N/ha	18.5 a	18.4 a	10.8 a	6.6 c	-	3.8 a
300 kg N/ha	19.3 a	18.5 a	10.5 a	5.9 b	-	4.4 a
400 kg N/ha	18.7 a	18.0 a	10.0 a	5.2 a	-	4.0 a
Nitrogen timing:						
All @ planting	18.9 a	18.4 a	10.6 a	5.8 a	-	4.0 a
½ @ planting + ½ @ hilling	18.8 a	18.1 a	10.3 a	6.0 a	-	4.1 a

[z]Marketable grade includes tubers between 20-40 mm diameter profile.

Within each factor, values followed by same letter are not significantly different at $P<0.05$ level of probability.

Table 3-9. Analyses of variance results on the effects of seed-piece spacing, nitrogen rate and nitrogen timing effects on oversize[z] yield for selected potato cultivars: 2007 - 2009

Source	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
			2007			
Spacing (S)	ns	ns	ns	ns	ns	-
Nitrogen rate (R)	ns	***(0.9)	**(0.4)	ns	ns	-
Nitrogen timing (T)	ns	***(0.6)	ns	ns	ns	-
S x R	ns	*(1.2)	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2008			
Spacing (S)	ns	ns	ns	*(1.6)	*(0.6)	-
Nitrogen rate (R)	ns	ns	ns	ns	ns	-
Nitrogen timing (T)	ns	ns	ns	ns	ns	-
S x R	ns	ns	ns	ns	ns	-
S x T	ns	ns	ns	ns	ns	-
R x T	ns	ns	ns	ns	ns	-
S x R x T	ns	ns	ns	ns	ns	-
			2009			
Spacing (S)	ns	ns	ns	ns	-	ns
Nitrogen rate (R)	*(1.1)	ns	ns	***(1.1)	-	ns
Nitrogen timing (T)	ns	ns	ns	ns	-	ns
S x R	ns	ns	ns	ns	-	ns
S x T	ns	ns	ns	ns	-	ns
R x T	ns	ns	ns	*(2.7)	-	ns
S x R x T	ns	ns	*(4.6)	ns	-	ns

[z]Oversize grade includes tubers larger than 40 mm diameter profile.

***, * and ns indicate significance at P<0.001, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimate at 5.0% level of significance.

Table 3-10. Seed-piece spacing, nitrogen rate and timing effects on oversize[z] tuber yield for selected potato cultivars: 2007 - 2009

Treatment	Oversize tuber yield (t/ha)[z]					
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Alpha	Norland
2007						
Seed piece spacing :						
15 cm	0.2 a	0.3 a	0.4 a	5.1 a	0.2 a	-
20 cm	0.1 a	0.4 a	0.3 a	4.6 a	0.1 a	-
Nitrogen rate:						
200 kg N/ha	0.3 a	0.5 b	0.8 b	6.0 a	0.2 a	-
300 kg N/ha	0.2 a	0.3 a	0.2 a	4.4 a	0.2 a	-
400 kg N/ha	0.1 a	0.2 a	0.1 a	4.1 a	0.1 a	-
Nitrogen timing:						
All @ planting	0.2 a	0.2 a	0.2 a	4.8 a	0.2 a	-
½ @ planting + ½ @ hilling	0.2 a	0.5 b	0.2 a	4.9 a	0.1 a	-
2008						
Seed piece spacing :						
15 cm	5.2 a	6.0 a	8.1 a	13.5 b	6.3 b	-
20 cm	4.8 a	6.2 a	7.9 a	11.7 a	5.5 a	-
Nitrogen rate:						
200 kg N/ha	5.6 a	5.7 a	8.6 a	13.0 a	6.4 a	-
300 kg N/ha	4.5 a	6.3 a	7.9 a	12.4 a	5.7 a	-
400 kg N/ha	4.9 a	6.3 a	7.5 a	12.3 a	5.6 a	-
Nitrogen timing:						
All @ planting	5.3 a	5.8 a	8.3 a	12.0 a	5.5 a	-
½ @ planting + ½ @ hilling	4.7 a	6.4 a	7.7 a	13.3 a	6.2 a	-
2009						
Seed piece spacing :						
15 cm	13.9 a	5.9 a	20.1 a	7.2 a	-	21.1 a
20 cm	12.1 a	7.3 a	16.3 a	6.3 a	-	18.2 a
Nitrogen rate:						
200 kg N/ha	13.9 b	7.3 a	19.1 a	8.4 c	-	20.4 a
300 kg N/ha	13.0 ab	6.1 a	18.7 a	6.7 b	-	19.2 a
400 kg N/ha	12.2 a	6.5 a	17.0 a	5.1 a	-	19.3 a
Nitrogen timing:						
All @ planting	12.9 a	6.2 a	17.2 a	6.1 a	-	19.8 a
½ @ planting + ½ @ hilling	13.1 a	7.0 a	19.2 a	7.4 a	-	19.5 a

[z]Oversize grade includes tubers larger than 40 mm diameter profile.

Within each factor, values followed by same letter are not significantly different at $P<0.05$ level of probability.

Harvest Management:

Top-kill Method and Timing on Growth and Yield Attributes for Contrasting Cultivars

(Interactive Effects of Seed-tuber Size and Seed Spacing)

BACKGROUND AND METHODOLOGY

Small potato crops are top-killed prematurely to limit tuber sizing and produce smaller tubers required by the target markets. In practice, top-kill stage of the crop is determined by test digs. Usually the crop is top-killed when two tubers per hill have reached the target size grade. Depending upon the vigour of the crop and the effectiveness of top-kill, there is a possibility that the tubers will continue to bulk even after top-kill resulting in higher proportion of oversize unmarketable tubers at the expense of marketable tubers. Delaying top-kill can result in more, unmarketable, oversized tubers. Tuber yields and size profile is influenced by many factors including the growing environment, cultivar characteristics (growth habit, maturity characters) agronomic practices such as seed size, seed-piece spacing and top-kill method and timing.

A series of inter-linked studies were conducted, 2007 through 2009, to examine the combined effects of seed tuber size and top-kill techniques on yield of small potato. These studies were conducted for dedicated small potato cultivars (Baby Boomer, Blushing Belle, Piccolo) and for standard table potato cultivars (AC Peregrine, Alpha, Norland) with potential for producing small potato. Trials were modified during successive years to address agronomic needs for providing recommendations on seed spacing and harvest techniques for small potato production utilizing dedicated small potato and Table potato cultivars.

2007:
The effects of seed size, seed spacing and top-kill timing were studied for Piccolo, Baby Boomer, Blushing Belle, AC Peregrine, Norland, and Alpha potato.

Study I:
For Piccolo, Baby Boomer and Blushing Belle, six seed-tuber grades (20-25, 25-30, 30-35, 35-40, 40-45, 45-50 mm diameter) were grown under two (15 and 20 cm) within-row seed spacing. The between-row row spacing was kept constant at 91 cm. The crops were flailed at 10, 11, and 12 weeks from planting for yield evaluation. Field plots were laid out in a Split-split-plot design with 4 replications for the each flail date. Main-plots included within-row spacing, Sub-plot included cultivar, Sub-sub-plot included seed size. The growing season received 178 mm rainfall and 205 mm irrigation.

Study II:
For, Norland, AC Peregrine, and Alpha three seed-tuber grades (20-30, 30-40, 40-50 mm diameter) were grown under three (10, 15, and 20 cm) within-row seed spacing. The between-row spacing was kept constant at 91 cm. The crops were flailed at 9, 10, and 11 weeks from planting for yield evaluation. Field plots were laid out in a Split-split-plot design with 4 replications for the each flail date. Main-plots included within-row spacing, Sub-plot included cultivar, Sub-sub-plot included seed size. The growing season received 178 mm rainfall and 205 mm irrigation.

2008:

Study I:

This study was designed to evaluate the effectiveness of flailing prior to chemical desiccation for tuber size control. The efficiency of flailing followed by desiccation using Reglone and desiccation without flailing in relation to tuber yield and size profile for three small potato cultivars (Baby Boomer, Blushing Belle, Piccolo) and four standard commercial cultivars (Bintje, Alpha, AC Peregrine, Norland) were compared. Three seed-tuber size (25-30, 30-35, 35-40 mm) were examined, two within-row seed-tuber spacings (15, 20 cm), and two top-kill method (flail and no flail). Field plots were laid out in a Split-split-plot design with 4 replications for the each cultivar. Main-plots included flailing, Sub-plot included seed spacing, Sub-sub-plot included seed size. The crops received 136 mm of rain and 300 mm of irrigation.

Study II:

This study was designed to examine the effect of timing of top-kill on yield and tuber size profiles. Comparisons were made between yields of crops that were top-killed at the appropriate stage and past the ideal stage, i.e. a crop that was top-killed one week later.

This study examined the effect timely and delayed top-kill on marketable yields for two small potato cultivars (Baby Boomer, Piccolo) and two table potato cultivars (AC Peregrine, Norland) grown for small potato production. The effects of two seed-tuber sizes (large, small), two within-row spacing (15, 20 cm) and two top-kill timing (when two tubers per plant reach >40 mm – Stage I, One week after first flail – Stage II) were evaluated. Field plots were laid out in a Split-split-plot design with 4 replications for the each flail date. Main-plots included flailing stage, Sub-plot included seed-tuber size, Sub-sub-plot included seed size. The 'large' seeds consisted of tubers >40 mm in diameter, and 'small' seed consisted of tuber 30-40 mm in diameter. The growing season received 178 mm rainfall and 205 mm irrigation.

2009:

The Study II from 2008 was repeated during 2009 with the same cultivars and treatment combinations. The growing season received 132 mm rainfall and 280 mm irrigation.

RESULTS

2007 – Study I:

Emergence:

Fifty percent of emergence occurred approximately 28 to 31 days from planting (Table 4-1). Baby Boomer and Piccolo emerged 27 to 28 days from planting. Blushing Belle emerged approximately a day later.

Larger seed emerged earlier than small seed (Table 4-1, Plate 4-1).

Seed spacing generally had no effect on 50% emergence.

Flowering:
Flowering occurred approximately 60 days from planting (Table 4-1). Generally, there was no difference in flowering date for the various cultivar, seed spacing, or seed size.

Leaf Area Index (LAI):
Leaf Area Indices at first flower as influenced by cultivar, seed size, and seed spacing for the 10, 11, and 12 week flailing periods are summarized in Table 4-2.

Baby Boomer and Piccolo produced higher LAI than Blushing Belle, although the differences were not significant in several instances (Table 4-2).

Seed spacing had no effect on LAI at flowering or at the various stages of flailing.

Seed size significantly affected LAI, i.e. larger seeds produced higher LAI (Table 4-2).

At the first flower stage, seed size and LAI relationships assumed linear response (Figure 4-1). The nearly parallel regression lines for the various flailing treatments indicate similar seed size vs LAI relationship, although the 11 week flailing test showed higher LAI across all seed sizes.

At 10, 11, and 12 weeks (i.e. prior to flailing), larger seed tended to produce higher LAI and the responses assumed quadratic relationships (Figure 4-1). The overall LAI decreased with advancing crop age.

Tuber Yield:
Tubers produced in a hill for Baby Boomer and Piccolo are presented in Plate 4-2 and Plate 4-3 respectively.

Marketable and oversize tuber yields in response to seed size, seed spacing, and timing of flailing for Baby Boomer, Blushing Belle, and Piccolo potato are summarized in Table 4-3.

Piccolo produced highest, Blushing Belle the second highest and Baby Boomer the lowest marketable tuber yields respectively across all flailing dates (Table 4-3). Baby Boomer produced 1.0, 3.4, and 4.9 t/ha marketable yields when the crop was flailed at 10, 11, and 12 weeks from planting respectively (Table 4-3). Piccolo outyielded Baby Boomer by 6-fold at 10 week flailing, 3-fold at 11-week flailing and 76% at 12-week flailing.

Delaying flailing from 10 to 12 weeks progressively increased marketable yield for Baby Boomer and Blushing Belle (Table 4-3, Figure 4-3). However, for Piccolo yield at 12 week flailing was slightly lower than 11 week flailing.

Delaying flailing resulted in higher yields of oversize tubers. This increase was more marked during the latter growth stages (Figure 4-4).

Closer seed spacing of 15 cm produced higher marketable and oversize yields than wider spacing of 20 cm at all flailing stages, except at 12 week flailing where the two spacings produced similar oversize yields (Table 4-3).

Seed size significantly affected both marketable and oversize tuber yields. Larger seed produced higher marketable and oversize yields relative to smaller seed at the various flailing dates (Table 4-3, Figure 4-5, Figure 4-6). The relationship between tuber yield (marketable and oversize) and seed tuber size assumed linear and quadratic responses. Piccolo, Blushing Belle, and Baby Boomer produced the highest, second highest, and lowest yields respectively for the various seed sizes during all flailing stages (Figure 4-5, Figure 4-6). The significant cultivar x seed size interaction with respect to marketable and oversize yields (Table 4-3) is reflected in the seed size vs tuber yield response curves (Figure 4-5, Figure 4-6).

2007 - Study II

Emergence:

Fifty percent of emergence occurred approximately 25 to 27 days from planting (Table 4-4). Norland emerged two to three days earlier than Alpha or AC Peregrine.

Seed size and seed spacing generally had no effect on 50% emergence.

Flowering:

AC Peregrine flowered approximately 51-52 days after planting, Norland 53-54 days after planting, and Alpha approximately 66-67 days after planting (Table 4-4).

Seed size and seed spacing had no effect on days to first flower (Table 4-4).

Leaf Area Index (LAI):

Leaf Area Indices at first flower for the different flailing tests and during flailing at 9, 10, and 11 week from planting are summarized in Table 4-5. LAI for the various cultivars at flowering ranged between 2.4 to 3.8. LAI prior to flailing at 9, 10, and 11 weeks from planting averaged at 3.9, 2.5, and 3.9 respectively.

There were no identifiable trends with respect to LAI for the various cultivars at flowering at the different flailing stages (Table 4-5). The various cultivars produced similar LAI at flowering. However at the different flailing stages, AC

Peregrine produced the highest LAI and Norland produced lowest LAI, but the differences were not significant at 9 week flailing.

Seed size and seed spacing generally had no effect on LAI.

Tuber Yield:
Tubers produced in a hill for AC Peregrine and Norland are presented in Plate 4-4 and Plate 4-5 respectively.

Marketable tuber yields in response to seed size, seed spacing, and timing of flailing for AC Peregrine, Alpha, and Norland potato are summarized in Table 4-6. The average marketable yields were 4.8, 5.6, and 5.8 t/ha when flailed at 9, 10, and 11 weeks after planting respectively. The corresponding oversize yields were 1.9, 5.6, and 12.4 t/ha respectively.

At 9 week flailing, Norland produced the highest marketable yield, AC Peregrine the second highest, and Alpha the lowest yield (Table 4-6). At 10 week flailing, all three cultivars produced similar marketable yields. The marketable yield trend at 11 week flailing was Alpha > Norland = AC Peregrine.

Closer (10 cm) seed spacing produced higher marketable tuber yields than wider (20 cm) row spacing at the 9, 10, or 11 week flailing (Table 4-6). However, seed-piece spacing had no effect on oversize tuber yields at the various flailing stages.

The yield trends for oversize tubers were Norland > AC Peregrine > Alpha at all three flailing stages (Table 4-6).

Larger seed produced higher marketable and oversize yields than smaller seed at the 9, 10, and 11 week flailing stages (Table 4-6).

2008 – Study I:
Mainstem Count:
The mainstem numbers averaged between 1.8 and 3.4 for the various cultivar and treatments (Table 4-7). Top-kill method and seed-piece spacing had no effect on mainstem numbers. However, larger seed-tubers produced significantly higher number of mainstems than smaller seed-tubers.

Flowering:
Baby Boomer, Piccolo, Blushing Belle, AC Peregrine, Norland, and Bintje flowered between 60 to 65 days from planting, whereas, Alpha flowered after 73 days (Table 4-8). Top-kill method and spacing had no effect on flowering date. However, plants from larger seed flowered one or two days earlier than plants from smaller seed in the various cultivars.

Leaf Area Index (LAI):
Leaf Area indices (LAI) recorded at flowering and at the top-kill stages for the various cultivars are summarized in Tables 4-9 and 4-10 respectively.

LAI at flowering ranged between 3.5 (i.e. Norland) and 5.5 (i.e. Baby Boomer). Within-row seed spacing of 15 cm produced slightly (non-significant) higher LAI than 20 cm seed spacing at flowering for all cultivars except Alpha that recorded significantly higher LAI at 15 cm spacing than 20 cm spacing (Table 4-9).

At flailing, the LAI of all cultivars declined due to senescence (Table 4-10). LAI at flailing ranged between 2.5-2.6 (i.e. Alpha, Bintje, Piccolo, Blushing Belle, Norland) and 3.3 (AC Peregrine, Baby Boomer). Within-row seed spacing of 15 cm produced slightly (non-significant) higher LAI than 20 cm seed spacing at the top-kill stage for all cultivars except for AC Peregrine that recorded significantly higher LAI at 15 cm spacing than 20 cm spacing (Table 4-10).

Significant interaction effects of treatment for the various cultivars (Table 4-10) did not show any identifiable agronomic trends.

Tuber Yield:
Marketable tuber yields in response to seed size, seed spacing, and top-kill method for Baby Boomer, Piccolo, Blushing Belle, AC Peregrine, Alpha, Bintje, and Norland potato are summarized in Table 4-11. The average yields were 8.4 t/ha for Baby Boomer, 15.5 t/ha for Piccolo, 6.9 t/ha for Blushing Belle, 6.0 t/ha for AC Peregrine, 3.9 t/ha for Alpha, 6.9 t/ha Bintje, and 4.1 t/ha for Norland (Table 4-11).

Larger seed-tubers of all cultivars produced higher marketable tuber yields than smaller seed (Table 4-11).

Seed-piece spacing had no effect on marketable yield for all cultivars (Table 4-1).

Top-kill method had no effect on marketable tuber yield for Baby Boomer, Piccolo, AC Peregrine, Alpha, and Bintje potato (Table 4-11). Blushing Belle and Norland showed contrasting responses to top-kill method, i.e. flailed Norland produced higher tuber yield than the crop desiccated without flailing. By contrast flailed Blushing Belle produced lower tuber yield than the un-flailed crop.

Significant Flailing x Spacing interactions for marketable yield were observed for Baby Boomer and Norland (Table 4-11, Figure 4-7). These two cultivars responded differently in relation to the effects of top-kill method and seed spacing on marketable tuber yield (Figure 4-7). For Baby Boomer, flailing produced lower yield at 15 cm seed spacing relative to 20 cm spacing. By contrast, the un-flailed crop produced higher tuber yields at 15 cm spacing relative to 20 cm spacing.

Oversize tuber yields in response to seed size, seed spacing, and top-kill method for Baby Boomer, Piccolo, Blushing Belle, AC Peregrine, Alpha, Bintje, and Norland potato are summarized in Table 4-12.

Top-kill without flailing resulted in higher oversize yields for Piccolo, Blushing Belle, AC Peregrine and Norland (Table 4-12). This yield increase was 39% for Piccolo, 14% for Blushing Blue, 80% for AC Peregrine, and 35% for Norland. Top-kill, with and without flailing produced similar oversize yields for Baby Boomer, Alpha, and Bintje. This indicates that flailing prior to desiccation is a preferred practice to minimize the proportion of oversize tubers.

The 15 cm seed-piece spacing produced higher oversize yields for Baby Boomer and Blushing Belle (Table 4-12). Seed piece spacing did not affect oversize yields for the other cultivars.

Larger seed generally produced higher oversize yields and the differences reached significant proportions for Piccolo, Blushing Belle, AC Peregrine and Norland (Table 4-12).

The interactive effect of seed size and flailing on over-size tuber yield was variable for Piccolo, AC Peregrine, Norland, and Baby Boomer (Table 4-12, Figure 4-8). Flailing resulted in lower over-size yields for Piccolo, AC Peregrine and Norland. The yield loss was more marked for the crop raised from smaller seed relative to the crop from larger seed. Baby Boomer responded differently to Piccolo, AC peregrine, or Norland. i.e. there was no yield decline in over-size tuber yield due to flailing compared to the un-flailed crop (Figure 4-8).

2008 – Study II and 2009 - Study:

Mainstem Count:

Top-kill stage and seed spacing generally had no effect on mainstem count for Baby Boomer, Piccolo, AC Peregrine, or Norland potato in 2008 or 2009 (Table 4-13).

Larger seed generally produced more mainstems than smaller seed, and the differences reached significant proportions in some instances (Table 4-13). For example, larger seed of AC Peregrine produced more mainstems than smaller seed in both 2008 and 2009 (Table 4-13). Larger seed produced significantly more mainstems for Baby Boomer in 2009 and Norland in 2008. Seed size had no effect on mainstem count of Baby Boomer or Piccolo potato (Table 4-13).

Flowering:

Flowering occurred approximately 60 days from planting for all cultivars during 2008 and 2009 (Table 4-14).

Top-kill stage and seed-piece spacing had no effect on flowering date in both years, except in 2009, where Norland spaced at 15 cm flowered one day earlier than the 20 cm spacing (Table 4-14).

Crops produced from larger seed-pieces flowered a few days earlier than crops raised using smaller seed pieces, except for Piccolo in 2009 (Table 4-14).

Leaf Area Index (LAI):
LAI's at flowering and at flailing in response to top-kill stage, seed spacing, and seed-piece size for the various cultivars are summarized in Tables 4-15 and 4-16 respectively.

At flowering, LAI averaged 4.0, 3.7, 4.3, and 3.0 for Baby Boomer, Piccolo, AC Peregrine and Norland in 2008; and 3.8, 2.5, 4.7, and 2.8 in 2009 respectively (Table 4-15). Top-kill stage, seed spacing, and seed-piece size had no effect on LAI of any cultivar. Except for Norland in 2009, top-kill stage, seed spacing or seed size had no effect on LAI at flowering during both 2008 and 2009 (Table 4-15).

LAI at flailing for Baby Boomer, Piccolo, AC Peregrine, and Norland averaged 5.7, 4.1, 5.6, 3.7; and 3.2, 3.4, 5.0, and 3.0 in 2009 respectively (Table 4-16). Seed-piece spacing did not affect LAI of any cultivar at flailing. In 2008, the response of LAI to seed size was variable among the cultivars. For example, large Baby Boomer seed produced higher LAI than small seed; small AC Peregrine seed produced higher LAI than large seed; while seed size had no effect on LAI for Piccolo and Norland. In 2009 seed size had no effect on LAI at flailing.

Tuber Yield:
Marketable Yield:
Baby Boomer, Piccolo, AC Peregrine, and Norland averaged 9.2, 12.3, 6.1, and 5.1 t/ha marketable yields in 2008; and 20.3, 18.5, 6.7, and 4.9 t/ha in 2009 respectively (Table 4-17).

Delaying top-kill by one week had no effect on marketable yield except in 2008 where late top-killed Norland produced higher marketable yield than the early top-killed crop (Table 4-17).

Seed piece spacing had no effect on marketable yield except in 2008 where closer spaced (15 cm) Norland produced higher marketable yield than the wider (20 cm) spaced crop (Table 4-17).

For all cultivars, crops raised using larger seed produced higher marketable tuber yields than crops grown using smaller seed. This yield increase reached significant proportion with Baby Boomer in 2008, Piccolo and AC Peregrine in 2009, and Norland in both 2008 and 2009 (Table 4-17).

Oversize Yield:
Oversize yields for Baby Boomer, Piccolo, AC Peregrine, and Norland averaged 2.4, 3.8, 10.8, and 8.0 t/ha in 2008; and 12.8, 20.2, 20.4, and 30.7 t/ha in 2009 respectively (Table 4-18).

Delaying top-kill by one week generally produced higher oversize yields compared to early top-kill in both 2008 and 2009 (Table 4-18).

Seed piece spacing had no effect on oversize yield except in 2009 where closer spaced (15 cm) AC Peregrine produced higher oversize yield than the wider (20 cm) spaced crop (Table 4-18).

For all cultivars, crops raised using larger seed produced higher oversize tuber yields than crops grown using smaller seed. This yield increase reached significant proportion with Baby Boomer in 2008, Piccolo in 2009, and AC Peregrine and Norland in both 2008 and 2009 (Table 4-18).

Table 4-1. Seed size and seed spacing effects on days to 50% emergence and days to first flowering for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007

Treatment	Days to 50% emergence			Days to first flower		
	10 week flailing	11 week flailing	12 week flailing	10 week flailing	11 week flailing	12 week flailing
Seed spacing:						
15 cm	29	28	28	62	60	60
20 cm	30	29	29	62	60	60
Cultivar:						
Baby Boomer	29	28	27	62	60	60
Blushing Belle	31	29	29	62	60	60
Piccolo	29	28	28	63	60	60
Seed size:						
20 mm - 25 mm	31	29	29	63	60	61
25 mm - 30 mm	31	28	28	62	60	60
30 mm - 35 mm	30	29	29	62	60	60
35 mm - 40 mm	29	28	28	62	60	60
40 mm - 45 mm	29	28	28	62	60	60
45 mm - 50 mm	28	28	28	62	60	60
ANOVA						
Source						
Seed spacing (S)	ns	*(0.5)	ns	ns	ns	ns
Cultivar (C)	***(0.4)	**(0.9)	***(0.6)	**(0.5)	ns	ns
Seed size (Z)	ns	*(0.9)	***(0.8)	**(0.6)	ns	ns
S x C	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns
C x Z	***(1.2)	ns	***(1.4)	ns	ns	ns
S x C x Z	ns	ns	ns	ns	ns	ns
C.V (%)	4.1	5.6	4.9	1.7	1.1	1.5

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-2. Seed size and seed spacing effects on Leaf Area Index at flowering and at flailing for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007

Treatment	Leaf Area Index					
	10 week flailing		11 week flailing		12 week flailing	
	At flowering	At flailing	At flowering	At flailing	At flowering	At flailing
Seed spacing:						
15 cm	2.4	3.1	2.1	2.8	1.9	2.0
20 cm	2.1	3.1	2.0	2.7	2.1	1.9
Cultivar:						
Baby Boomer	2.5	3.2	2.3	2.6	2.2	1.9
Blushing Belle	1.9	3.1	1.7	2.7	1.7	1.9
Piccolo	2.3	3.1	2.2	3.0	2.1	2.1
Seed size:						
20 mm - 25 mm	1.7	2.8	1.6	2.5	1.1	1.6
25 mm - 30 mm	1.8	2.8	1.8	2.5	1.2	1.8
30 mm - 35 mm	2.2	3.1	1.8	2.9	2.0	2.0
35 mm - 40 mm	2.4	3.3	2.2	2.7	2.6	2.2
40 mm - 45 mm	2.2	3.1	2.4	3.0	2.7	2.1
45 mm - 50 mm	3.0	3.4	2.7	2.9	2.3	2.3
ANOVA						
Source						
Seed spacing (S)	ns	ns	ns	ns	ns	*(0.1)
Cultivar (C)	ns	ns	*(0.4)	ns	*(0.3)	ns
Seed size (Z)	***(0.6)	*(0.5)	***(0.5)	ns	***(0.4)	**(0.4)
S x C	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns
C x Z	ns	ns	ns	ns	ns	ns
S x C x Z	ns	ns	*(1.2)	ns	ns	ns
C.V (%)	44.3	27.7	41.1	32.4	37.7	30.9

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-3. Seed size and seed spacing effects on marketable and oversize yields for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007

Treatment	Marketable yield (t/ha)[Z]			Oversize tuber yield (t/ha)[Y]		
	10 week flailing	11 week flailing	12 week flailing	10 week flailing	11 week flailing	12 week flailing
Seed spacing:						
15 cm	3.2	6.5	6.8	0.5	2.2	5.3
20 cm	2.5	5.1	6.2	0.4	1.8	5.3
Cultivar:						
Baby Boomer	1.0	3.4	4.9	0.1	0.2	0.9
Blushing Belle	1.3	5.0	6.1	0.1	1.7	6.5
Piccolo	6.2	9.1	8.6	1.3	4.1	8.5
Seed size:						
20 mm - 25 mm	1.2	3.5	3.5	0.1	1.1	2.0
25 mm - 30 mm	1.9	4.5	4.7	0.3	1.1	3.2
30 mm - 35 mm	2.5	5.4	6.5	0.5	1.6	4.6
35 mm - 40 mm	3.4	6.4	7.7	0.6	2.2	6.5
40 mm - 45 mm	3.8	7.0	8.2	0.7	2.8	7.4
45 mm - 50 mm	4.5	8.2	8.5	0.6	3.3	8.1
ANOVA						
Source						
Seed spacing (S)	*(0.7)	***(0.3	ns	*(0.1)	**(0.2)	ns
Cultivar (C)	***(0.7)	***(0.5)	***(0.6)	***(0.2)	***(0.5)	***(1.0)
Seed size (Z)	***(0.7)	***(0.7)	***(0.8)	***(0.3)	***(0.5)	***(0.7)
S x C	ns	**(0.7)	*(0.9)	ns	ns	ns
S x Z	ns	ns	ns	ns	**(0.7)	ns
C x Z	***(1.3)	***(1.3)	***(1.3)	***(0.4)	***(0.8)	***(1.3)
S x C x Z	ns	ns	ns	ns	***(1.2)	ns
C.V (%)	44.6	21.9	20.4	96.1	40.8	24.1

[Z]Marketable grade includes tubers 20-40 mm diameter profile.

[Y]Oversize grade includes tubers larger than 40 mm diameter profile.

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-4. Seed size and seed spacing effects on days to 50% emergence and days to first flower for AC Peregrine, Alpha, and Norland potato when flailed at 9, 10, and 11 weeks from planting; 2007-

Treatment	Days to 50% emergence			Days to first flower		
	9 week flailing	10 week flailing	11 week flailing	9 week flailing	10 week flailing	11 week flailing
Seed spacing:						
10 cm	25.3	26.1	25.6	57	57	57
15 cm	25.9	26.0	25.6	58	57	57
20 cm	27.0	25.8	26.3	57	57	57
Cultivar:						
AC Peregrine	27.0	26.9	26.9	52	52	51
Alpha	26.6	26.5	26.6	67	67	66
Norland	24.6	24.6	24.0	53	53	54
Seed size:						
< 30 mm	26.4	26.2	26.6	57	58	57
30 - 40 mm	25.8	25.9	25.6	57	57	57
40 - 50 mm	26.1	25.8	25.3	57	57	57
ANOVA						
Source						
Seed spacing (S)	ns	ns	ns	ns	ns	ns
Cultivar (C)	***(0.5)	***(0.7)	***(0.8)	***(0.5)	***(0.4)	***(0.7)
Seed size (Z)	*(0.4)	ns	***(0.4)	ns	ns	ns
S x C	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns
C x Z	*(0.7)	ns	ns	***(0.7)	**(0.6)	ns
S x C x Z	ns	ns	ns	ns	**(1.0)	ns
C.V (%)	3.0	3.8	2.9	1.5	1.2	1.3

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-5. Seed size and seed spacing effects on Leaf Area Index for AC Peregrine, Alpha, and Norland potato when flailed at 9, 10, and 11 weeks from planting: 2007

Treatment	Leaf Area Index					
	9 week flailing		10 week flailing		11 week flailing	
	At flowering	At flailing	At flowering	At flailing	At flowering	At flailing
Seed spacing:						
10 cm	3.6	4.3	3.2	2.6	3.0	3.9
15 cm	3.6	3.7	3.0	2.4	2.6	3.9
20 cm	3.5	3.9	2.9	2.4	2.4	3.8
Cultivar:						
AC Peregrine	3.8	4.0	3.0	2.9	2.9	4.3
Alpha	3.2	3.9	3.0	2.4	2.7	3.8
Norland	3.7	3.9	3.2	2.2	2.4	3.5
Seed size:						
< 30 mm	3.4	4.0	3.1	2.5	2.6	3.9
30 - 40 mm	3.5	3.9	3.2	2.6	2.5	3.9
40 - 50 mm	3.8	3.9	2.8	2.3	2.8	3.9
ANOVA						
Source						
Seed spacing (S)	ns	*(0.5)	ns	ns	ns	ns
Cultivar (C)	*(0.5)	ns	ns	***(0.3)	ns	***(0.3)
Seed size (Z)	ns	ns	ns	**(0.2)	ns	ns
S x C	ns	ns	ns	ns	ns	ns
S x Z	*(0.7)	ns	ns	ns	ns	ns
C x Z	ns	ns	ns	ns	ns	ns
S x C x Z	ns	ns	ns	ns	ns	ns
C.V (%)	22.2	21.9	25.1	20	23.2	17.7

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-6. Seed size and seed spacing effects on marketable and oversize yields for AC Peregrine, Alpha, and Norland potato when flailed at 9, 10, and 11 weeks from planting

Treatment	Marketable yield (t/ha)[z]			Oversize tuber yield (t/ha)[y]		
	9 week flailing	10 week flailing	11 week flailing	9 week flailing	10 week flailing	11 week flailing
Seed spacing:						
10 cm	5.3	6.4	6.8	2.2	5.6	13.1
15 cm	4.9	5.6	5.8	1.8	5.7	12.4
20 cm	4.2	4.8	4.8	1.7	5.6	11.6
Cultivar:						
AC Peregrine	4.9	5.7	4.6	1.3	6.3	15.0
Alpha	2.5	5.3	7.5	0.3	1.3	2.8
Norland	7.1	5.8	5.2	4.0	9.3	19.3
Seed size:						
< 30 mm	3.9	5.3	5.5	1.5	4.7	11.1
30 - 40 mm	5.0	5.4	5.6	2.0	5.6	12.3
40 - 50 mm	5.6	6.1	6.2	2.2	6.6	13.7
ANOVA						
Source						
Seed spacing (S)	**(0.6)	***(0.5)	***(0.4)	ns	ns	ns
Cultivar (C)	***(1.0)	ns	***(0.9)	***(0.8)	***(1.3)	***(1.6)
Seed size (Z)	***(0.5)	***(0.4)	**(0.5)	**(0.4)	***(0.8)	***(1.0)
S x C	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns
C x Z	**(0.9)	**(0.8)	ns	ns	*(1.3)	ns
S x C x Z	*(1.6)	ns	ns	ns	ns	ns
C.V (%)	23.1	16.5	16.6	47.8	29.2	17.9

[z]Marketable grade includes tubers 20-40 mm diameter profile.

[y]Oversize grade includes tubers larger than 40 mm diameter profile.

***, **, *, and ns indicate significance at P< 0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-7. Effects of seed-tuber size, within-row seed spacing, and flailing method on the number of mainstems per hill for selected potato cultivars: 2008

Treatment	Mainstem number per hill						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	2.9	2.3	2.1	1.8	2.1	2.2	3.2
No flailing	3.4	2.4	2.3	1.8	2.2	2.1	3.0
Seed piece spacing:							
15 cm	3.0	2.4	2.2	1.9	2.1	2.2	3.2
20 cm	3.3	2.3	2.3	1.7	2.2	2.1	3.0
Seed-tuber diameter:							
25 - 30 mm	2.9	2.2	2.2	1.7	2.0	1.8	2.8
30 – 35 mm	3.3	2.4	2.2	1.8	2.0	2.2	3.2
35 – 40 mm	3.2	2.5	2.4	2.0	2.4	2.4	3.4
ANOVA							
Source:							
Flail (F)	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	ns
Seed diam.(D)	ns	*(0.3)	ns	**(0.1)	*(0.2)	***(0.2)	*(0.5)
F x S	*(0.9)	ns	*(0.7)	ns	ns	ns	ns
F x D	ns	ns	ns	ns	ns	ns	ns
S x D	ns	ns	ns	ns	ns	ns	ns
F x S x D	ns	ns	ns	ns	ns	ns	ns

***, **, *, and ns indicate significance at P<0.001, 0.01, and 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-8. Effects of seed-tuber size, within-row seed spacing, and flailing method on the flowering date for selected potato cultivars: 2008

Treatment	Days to flower						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	60	62	61	61	62	73	63
No flailing	60	63	62	62	63	73	65
Seed piece spacing:							
15 cm	60	62	61	61	63	73	63
20 cm	60	63	62	62	63	73	65
Seed-tuber diameter:							
25 - 30 mm	62	65	63	62	64	73	68
30 – 35 mm	60	61	62	61	63	73	63
35 – 40 mm	58	62	60	61	61	72	61
ANOVA							
Source:							
Flail (F)	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	ns
Seed diam.(D)	**(2)	***(1)	**(1)	**(1)	***(1)	ns	***(2)
F x S	***(2)	***(2)	ns	***(1)	*(3)	ns	ns
F x D	ns	ns	ns	ns	ns	ns	*(2)
S x D	ns	ns	ns	ns	ns	ns	ns
F x S x D	ns	ns	ns	ns	ns	ns	ns

***, **, *, and ns indicate significance at P<0.001, 0.01, and 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-9. Effects of seed-tuber size, within-row seed spacing and flailing method on Leaf Area Index at flowering for selected potato cultivars: 2008

Treatment	Leaf Area Index						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	3.1	2.7	2.6	3.2	2.5	2.8	2.4
No flailing	3.4	2.4	2.6	3.3	2.4	2.6	2.6
Seed piece spacing:							
15 cm	3.6	2.6	2.9	3.8	2.6	2.9	2.5
20 cm	3.0	2.5	2.4	2.7	2.4	2.5	2.5
Seed-tuber diameter:							
25 - 30 mm	3.3	2.7	2.7	3.2	2.5	2.9	2.4
30 – 35 mm	3.3	2.2	2.6	3.2	2.3	2.6	2.5
35 – 40 mm	3.1	2.7	2.6	3.3	2.6	2.6	2.6
ANOVA							
Source:							
Flail (F)	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	*(0.8)	ns	ns	ns
Seed diam.(D)	ns	*(0.5)	ns	ns	ns	ns	***(1.7)
F x S	ns	ns	ns	ns	ns	ns	ns
F x D	ns	*(0.7)	ns	ns	ns	ns	*(2.4)
S x D	ns	ns	ns	ns	ns	ns	ns
F x S x D	ns	ns	ns	ns	ns	ns	ns

***, *, and ns indicate significance at P<0.001, and 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-10. Effects of seed-tuber size, within-row seed spacing and flailing method on Leaf Area Index at flailing for selected potato cultivars: 2008

Treatment	Leaf Area Index						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	5.3	3.5	4.0	5.5	3.5	5.5	4.7
No flailing	5.7	3.7	3.8	5.3	3.6	5.8	4.6
Seed piece spacing:							
15 cm	5.5	3.8	3.9	5.8	3.6	5.9	4.7
20 cm	5.4	3.4	4.0	5.1	3.5	5.4	4.7
Seed-tuber diameter:							
25 - 30 mm	5.2	3.5	3.4	5.4	3.5	5.5	4.6
30 – 35 mm	5.5	3.5	4.1	5.6	3.7	5.6	4.7
35 – 40 mm	5.7	3.8	4.3	5.3	3.4	5.9	4.7
ANOVA							
Source:							
Flail (F)	*(0.3)	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	*(0.4)	ns
Seed diam.(D)	ns	ns	*(0.7)	ns	ns	ns	ns
F x S	ns	ns	ns	ns	ns	ns	*(0.6)
F x D	ns	ns	ns	ns	ns	ns	ns
S x D	ns	ns	ns	*(1.1)	ns	ns	*(0.7)
F x S x D	ns	ns	ns	ns	ns	ns	ns

* and ns indicate significance at P<0.05 level of probability and not significant respectively. Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-11. Effects of seed-tuber size, within-row seed spacing and flailing method on Marketable[z] tuber yield for selected potato cultivars: 2008

Treatment	Marketable tuber yield (t/ha)[z]						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	8.4	15.2	6.3	5.8	4.3	4.0	6.8
No flailing	8.3	15.8	7.4	6.1	3.9	3.7	7.0
Seed piece spacing:							
15 cm	8.7	15.7	7.6	6.2	4.2	4.2	7.2
20 cm	8.1	15.3	6.1	5.6	4.0	3.6	6.6
Seed-tuber diameter:							
25 - 30 mm	7.6	13.5	5.6	5.1	3.7	3.4	5.3
30 - 35 mm	8.5	16.1	7.0	5.9	3.9	3.9	6.9
35 - 40 mm	9.1	16.9	8.0	6.7	4.8	4.4	8.4
ANOVA							
Source:							
Flail (F)	ns	ns	*(0.8)	ns	**(0.2)	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	ns
Seed diam.(D)	**(0.8)	***(1.2)	**(1.5)	**(0.8)	***(0.6)	**(0.7)	***(1.0)
F x S	*(1.9)	ns	ns	ns	*(1.9)	ns	ns
F x D	ns	ns	ns	ns	ns	ns	ns
S x D	ns	ns	ns	ns	ns	ns	ns
F x S x D	ns	ns	ns	ns	ns	ns	ns

[z]Marketable grade includes tubers 20-40 mm diameter profile.

***, **, * and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-12. Effects of seed-tuber size, within-row seed spacing and flailing method on 'Oversize[z] tuber yield for selected potato cultivars: 2008

Treatment	Oversize tuber yield (t/ha)[z]						
	Baby Boomer	Piccolo	Blushing Belle	AC Peregrine	Norland	Alpha	Bintje
Top-kill method:							
Flail	2.2	3.9	5.6	3.8	11.0	1.6	1.1
No flailing	2.0	5.4	6.4	6.8	14.8	1.5	1.0
Seed piece spacing:							
15 cm	2.4	5.2	7.3	5.6	13.7	1.6	1.1
20 cm	1.7	4.1	4.7	5.0	12.1	1.5	1.0
Seed-tuber diameter:							
25 - 30 mm	1.8	3.6	4.4	4.5	11.8	1.6	0.8
30 - 35 mm	2.0	5.2	4.9	5.3	12.2	1.5	1.3
35 - 40 mm	2.4	5.3	8.6	6.0	14.7	1.6	1.1
ANOVA							
Source:							
Flail (F)	ns	**(0.6)	*(0.5)	*(2.7)	*(1.8)	ns	ns
Spacing (S)	**(0.4)	ns	*(2.3)	ns	ns	ns	ns
Seed diam. (D)	ns	**(1.1)	***(1.5)	*(1.2)	*(2.5)	ns	*(0.4)
F x S	**(0.6)	**(3.4)	ns	**(2.3)	*(4.9)	ns	ns
F x D	ns	ns	ns	ns	*(3.5)	ns	ns
S x D	ns	ns	ns	ns	ns	ns	ns
F x S x D	ns	ns	ns	ns	ns	ns	ns

[z]Oversize grade includes tubers larger than 40 mm diameter profile.

***, **, * and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-13. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on the number of mainstems per hill for selected potato cultivars: 2008 - 2009

Treatment	Mainstem number per hill							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill timing[z]*:*								
Stage-1	3.1	5.8	2.5	2.9	2.1	3.1	3.2	5.9
Stage-2	3.3	5.2	2.5	3.2	2.5	2.8	3.2	5.0
Seed piece spacing:								
15 cm	3.2	5.4	2.4	3.1	2.5	3.2	3.4	5.8
20 cm	3.2	5.4	2.6	3.0	2.1	2.7	3.1	5.1
Seed size:								
Large	3.2	6.6	2.6	3.2	2.7	3.6	3.9	7.0
Small	3.2	4.4	2.4	2.9	1.8	2.3	2.5	4.2
Source:								
Top-kill timing (T)	ns	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	*(0.3)	ns	ns	ns
Seed size (Z)	ns	***(0.9)	ns	ns	***(0.4)	***(0.5)	***(0.4)	ns
T x S	ns	ns	ns	ns	ns	ns	ns	ns
T x Z	ns	ns	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns	ns	ns
T x S x Z	ns	ns	ns	ns	ns	ns	ns	ns

[z]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

***, *, and ns indicate significance at P<0.001, and 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-14. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on days to flower for selected potato cultivars: 2008 - 2009

Treatment	Days to flower							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill timing[z]*:*								
Stage-1	60	64	62	64	60	62	61	65
Stage-2	61	64	62	64	60	62	60	65
Seed piece spacing:								
15 cm	61	64	61	63	60	62	60	65
20 cm	60	64	62	64	60	62	61	66
Seed size:								
Large	57	65	60	65	57	60	59	63
Small	64	64	63	63	63	64	62	67
Source:								
Top-kill timing (T)	ns	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	ns	*(1.1)
Seed size (Z)	***(3)	ns	*(2)	***(0.5)	*(1)	***(1.2)	*(2)	***(1.5)
T x S	ns	ns	ns	ns	ns	ns	ns	ns
T x Z	ns	ns	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns	ns	ns
T x S x Z	ns	ns	ns	ns	ns	ns	ns	ns

[z]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

***, *, and ns indicate significance at P<0.001, and 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-15. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on Leaf Area Index at flowering for selected potato cultivars

Treatment	Leaf Area Index							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill timing[z]*:*								
Stage-1	4.4	3.9	3.8	2.3	4.6	4.7	3.5	3.1
Stage-2	3.6	3.7	3.5	2.6	3.9	4.6	2.5	2.4
Seed piece spacing:								
15 cm	4.0	3.6	3.6	2.4	4.4	4.3	2.9	3.3
20 cm	4.0	4.0	3.7	2.5	4.1	4.9	3.1	2.2
Seed size:								
Large	4.2	3.6	3.5	2.5	4.3	4.8	3.1	2.8
Small	3.7	4.0	3.8	2.5	4.2	4.3	2.9	2.7
Source:								
Top-kill timing (T)	ns	ns	ns	ns	ns	ns	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	ns	*(1.0)
Seed size (Z)	ns	ns	ns	ns	ns	ns	ns	ns
T x S	ns	ns	ns	ns	ns	ns	ns	*(1.5)
T x Z	ns	ns	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns	ns	*(0.7)
T x S x Z	ns	ns	ns	ns	ns	ns	ns	ns
CV (%)								

[z]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

* and ns indicate significance at P<0.05 level of probability and not significant respectively.

Table 4-16. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on Leaf Area Index at flailing for selected potato cultivars

Treatment	Leaf Area Index							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill stage[z]*:*								
Stage-1	6.1	3.6	4.4	3.9	5.1	4.8	4.3	3.2
Stage-2	5.3	2.8	3.8	2.8	6.0	5.2	3.0	2.8
Seed piece spacing:								
15 cm	5.5	3.1	4.3	3.5	5.5	5.1	3.8	3.0
20 cm	5.8	3.3	3.9	3.1	5.6	4.9	3.5	3.0
Seed size:								
Large	6.1	3.3	3.9	3.1	5.3	4.9	3.9	3.0
Small	5.2	3.2	4.3	3.6	5.7	5.1	3.4	3.0
Source:								
Top-kill timing (T)	ns	ns	ns	*(0.8)	*(0.6)	ns	ns	*(1.0)
Spacing (S)	ns	ns	ns	ns	ns	ns	ns	ns
Seed size (Z)	*(0.9)	ns	ns	ns	*(0.4)	ns	ns	ns
T x S	ns	ns	ns	ns	ns	ns	ns	ns
T x Z	ns	ns	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns	ns	ns
T x S x Z	ns	ns	ns	ns	ns	ns	ns	ns

[z]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

*, and ns indicate significance at P<0.05 level of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-17. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on marketable[Z] tuber yield for selected potato cultivars: 2008 - 2009

Treatment	Marketable tuber yield (t/ha)[Z]							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill stage[Y]*:*								
Stage-1	8.8	21.1	12.3	18.7	6.2	7.6	4.6	5.3
Stage-2	9.6	19.5	12.3	18.2	5.9	5.7	5.5	4.5
Seed piece spacing:								
15 cm	9.2	19.8	12.8	19.9	6.1	6.8	5.3	5.4
20 cm	9.2	20.8	11.8	16.9	6.0	6.5	4.7	4.4
Seed size:								
Large	11.3	21.2	12.7	20.4	6.4	7.7	5.6	5.7
Small	7.1	19.4	11.9	16.5	5.7	5.6	4.4	4.0
Source:								
Top-kill timing (T)	ns	ns	ns	ns	ns	ns	*(0.5)	ns
Spacing (S)	ns	ns	ns	ns	ns	ns	**(0.3)	ns
Seed size (Z)	**(2.4)	ns	ns	**(2.2)	ns	**(1.1)	*(1.0)	***(0.7)
T x S	ns	ns	ns	ns	ns	*	ns	ns
T x Z	ns	ns	ns	ns	*(1.4)	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	ns	ns	ns
T x S x Z	ns	ns	ns	ns	ns	*	ns	ns
CV (%)								

[Z]Marketable grade includes tubers 20-40 mm diameter profile.

[Y]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

***, **, *, and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

Table 4-18. Effects of seed-tuber size, within-row seed spacing, and top-kill timing on oversize[Z] tuber yield for selected potato cultivars: 2008 - 2009

Treatment	Oversize tuber yield (t/ha)[Z]							
	Baby Boomer		Piccolo		AC Peregrine		Norland	
	2008	2009	2008	2009	2008	2009	2008	2009
Top-kill stage[Y]:								
Stage-1	1.9	11.3	3.6	19.3	7.4	17.2	7.2	29.8
Stage-2	2.9	14.3	4.0	21.1	14.1	23.5	8.7	31.6
Seed piece spacing:								
15 cm	2.7	14.2	3.4	18.8	11.0	22.5	7.9	32.6
20 cm	2.0	11.3	4.2	21.6	10.4	18.2	8.1	28.8
Seed size:								
Large	3.1	13.1	4.1	21.9	14.1	27.2	10.0	36.0
Small	1.7	12.5	3.5	18.5	7.4	13.5	6.1	25.4
Source:								
Top-kill timing (T)	ns	*(2.2)	ns	ns	*(5.5)	*(5.9)	ns	ns
Spacing (S)	ns	ns	ns	ns	ns	*(3.6)	ns	ns
Seed size (Z)	*(0.7)	ns	ns	*(2.6)	*(2.5)	***(1.5)	*(2.5)	**(5.1)
T x S	ns	ns	ns	ns	ns	ns	ns	ns
T x Z	ns	ns	ns	ns	ns	ns	ns	ns
S x Z	ns	ns	ns	ns	ns	**	ns	ns
T x S x Z	ns	ns	ns	ns	ns	***	ns	ns
CV (%)								

[Z]Oversize grade includes tubers larger than 40 mm diameter profile.

[Y]Top-kill-stage: Stage-1 = When two tubers per hill reached >40 mm in diameter; Stage-2 = One week after Stage-1 Top-kill.

***, **, *, and ns indicate significance at P<0.001, 0.01, 0.05 levels of probability and not significant respectively.

Values within parentheses are LSD estimates at 5.0% level of significance.

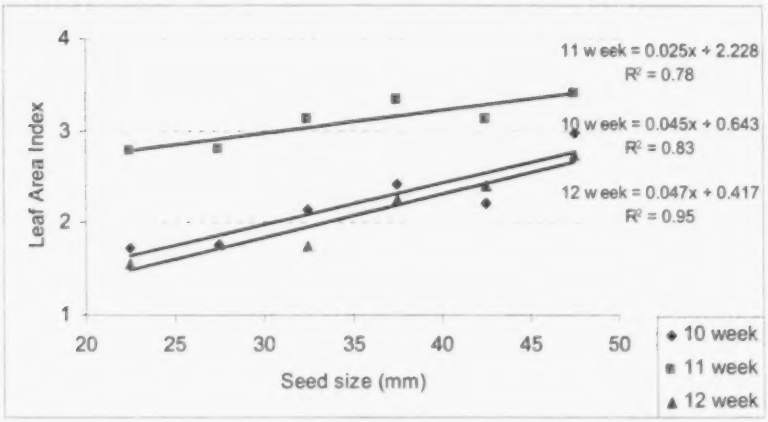


Figure 4-1. Seed size effect on Leaf Area Index at first flower stage for 10, 11, and 12 week flailing treatments: 2007.

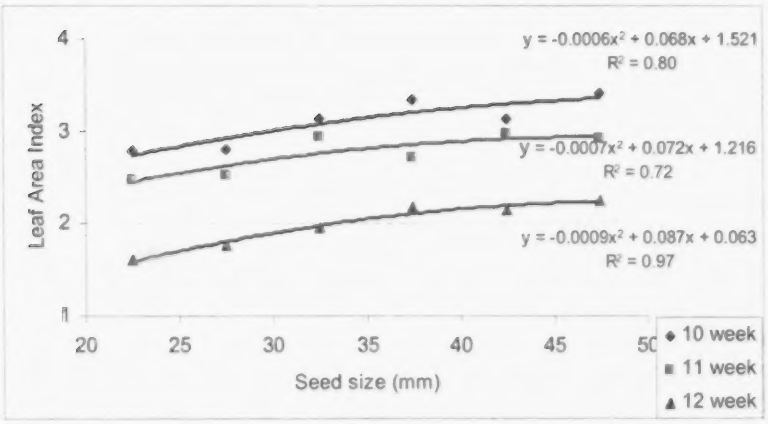


Figure 4-2. Seed size effect Leaf Area Indices prior to flailing at 10, 11, and 12 weeks from planting: 2007.

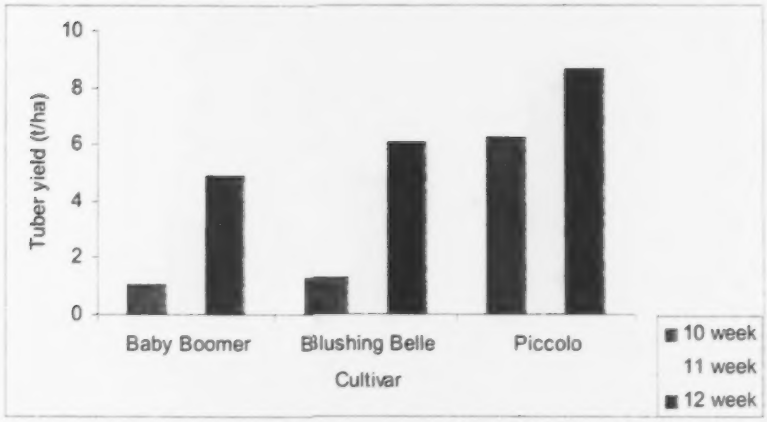


Figure 4-3. Marketable tuber yields for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007.

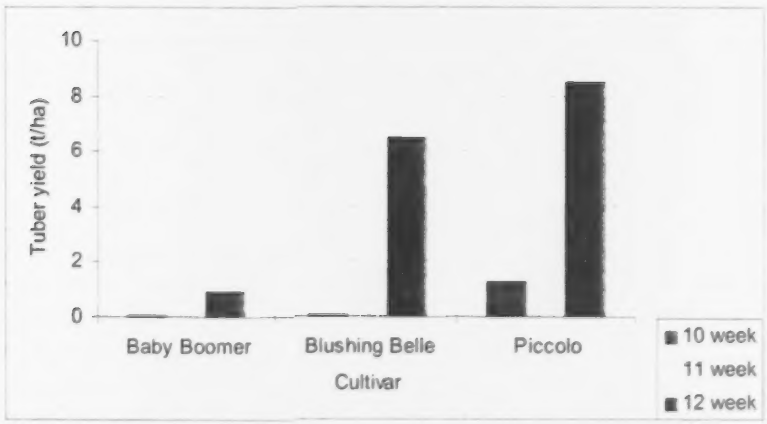
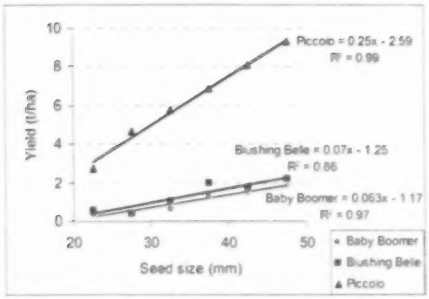
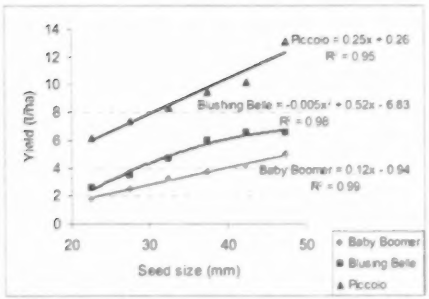


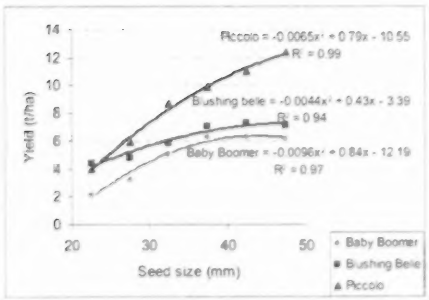
Figure 4-4. Oversize tuber yield for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007.



10-Week Flailing

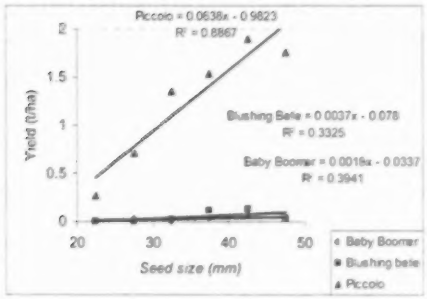


11-Week Flailing

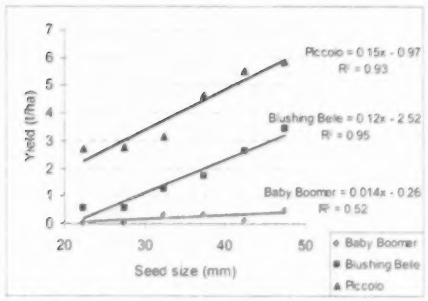


12-Week Flailing

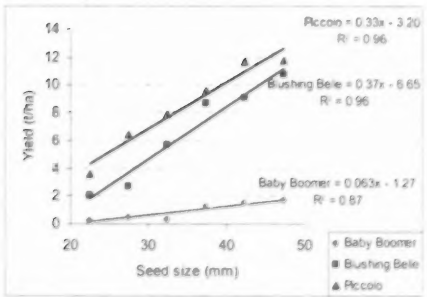
Figure 4-5. Seed size effect on marketable tuber yields for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007.



10-Week Flailing



11-Week Flailing



12-Week Flailing

Figure 4-6. Seed size effect on oversize tuber yields for Baby Boomer, Blushing Belle, and Piccolo potato when flailed at 10, 11, and 12 weeks from planting: 2007.

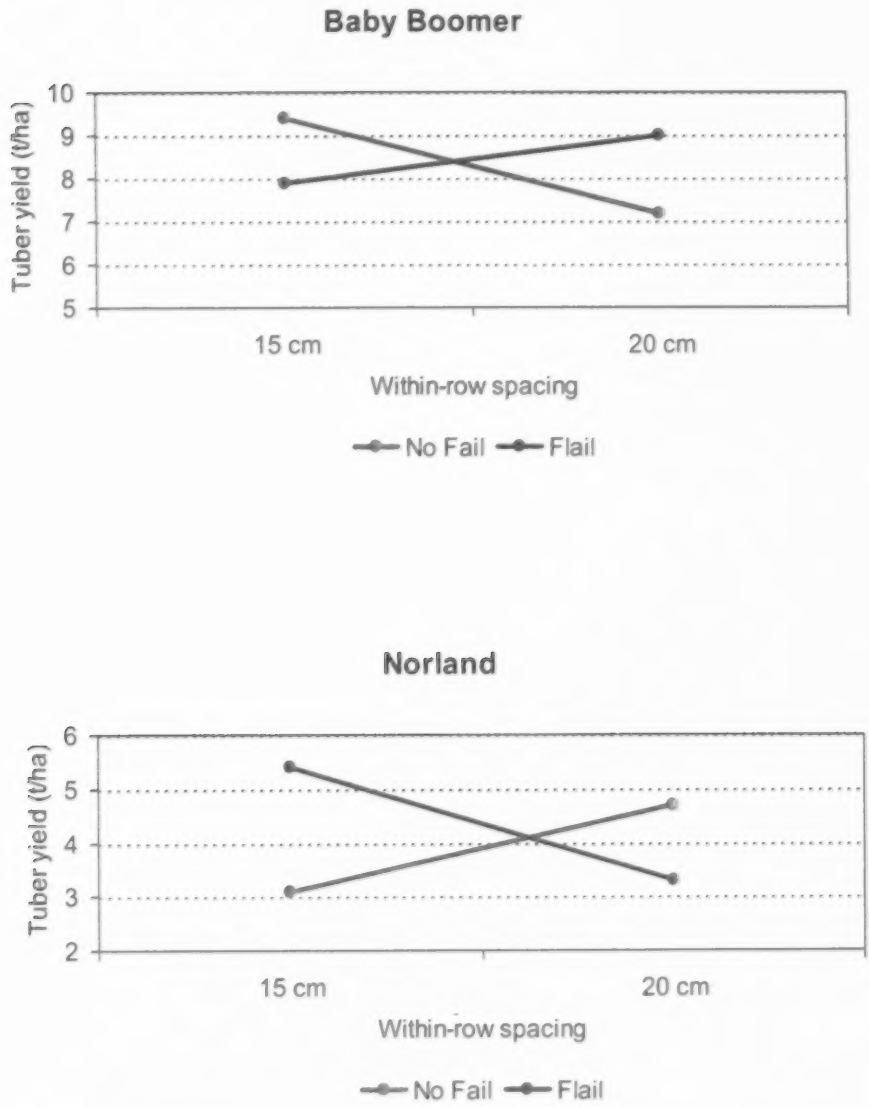


Figure 4-7. Interactive effects top-kill method and seed-piece spacing on marketable yield for Baby Boomer and Norland potato: 2008.

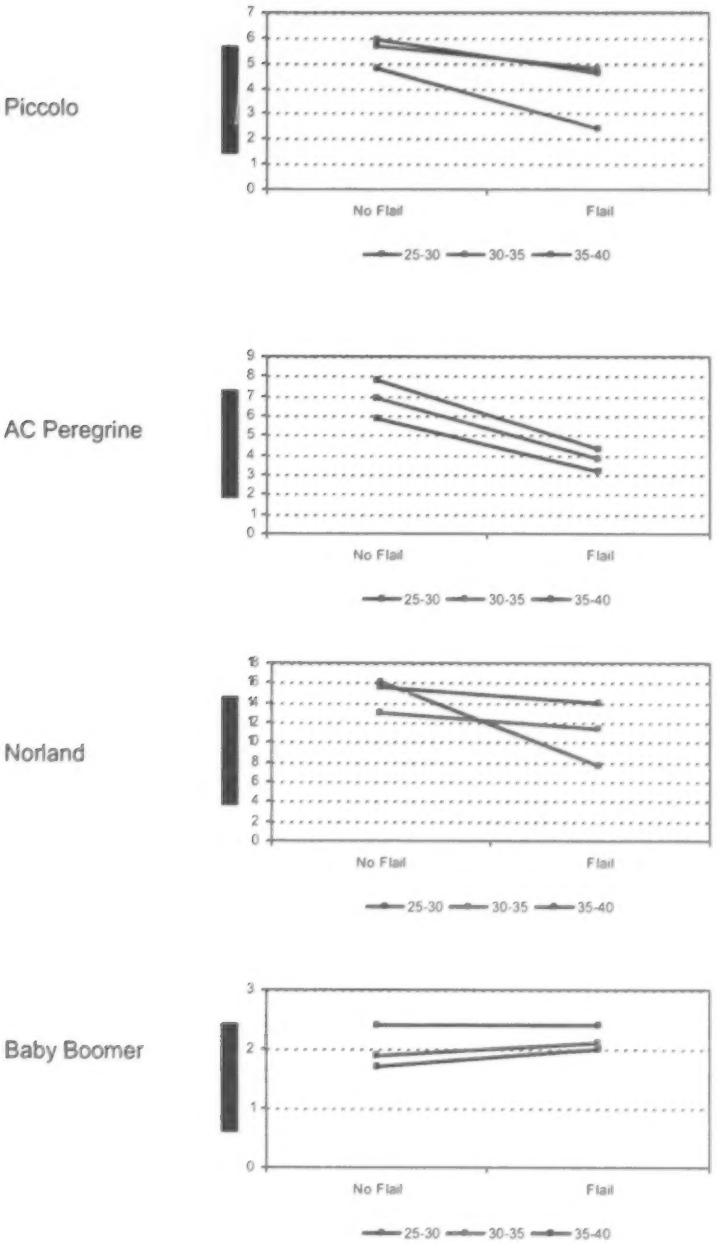


Figure 4-8. Interactive effects top-kill method and seed size on over-size yield for Piccolo, AC Peregrine, Norland and Baby Boomer potato: 2008.

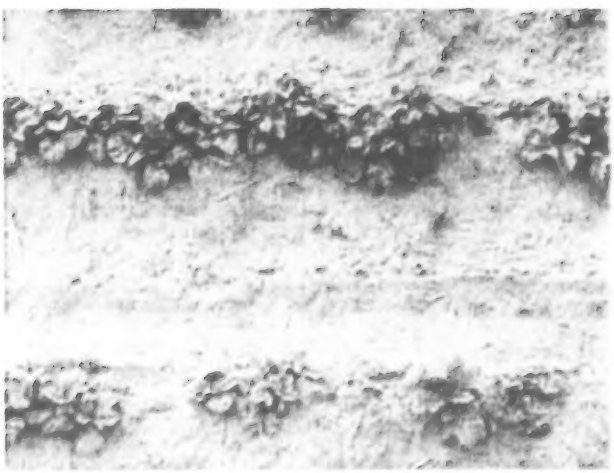


Plate 4-1. Potato emergence: Small seed in the foreground and large seed in the background.

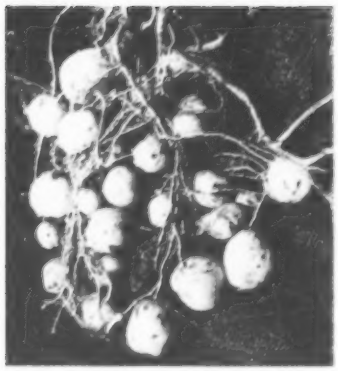


Plate 4-2. Baby Boomer.

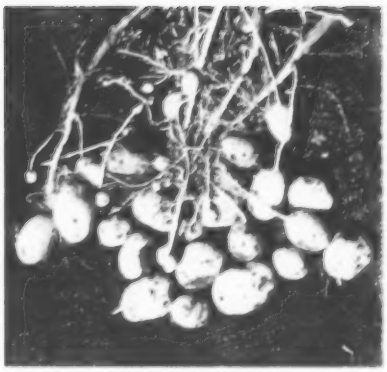


Plate 4-3. Piccolo.

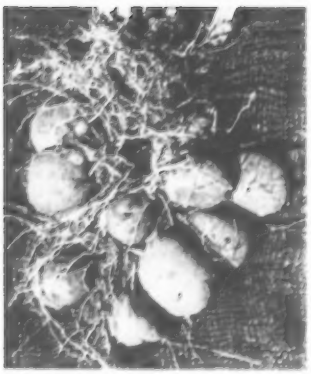


Plate 4-4. AC Peregrine.

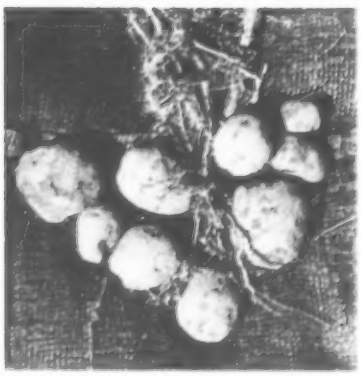


Plate 4-5. Norland.

Summary, Conclusions, and Recommendations

Recent health issues associated with traditional fried and processed potatoes and potato products in addition to the highly competitive potato markets have compelled the potato industry to search for healthier alternatives. 'Small' potatoes are a healthier, fresh and non-fry option with economic potential. The success of producing high quality small potato in a cost-effective manner depends on the use of superior cultivars and adopting appropriate agronomic practices.

North American and Canadian small potato markets mostly target tubers between 20 mm and 40 mm in diameter. However, slightly larger size profiles (up to 20 - 50 mm diameter) are sought by some market places.

Cultivar choice and agronomic practices utilized to produce standard (larger) potato cannot be directly applied for producing small potato. Standard potato production is targeted at maximizing yields of tubers larger than 40 mm to 50 mm. By contrast, small potato production is targeted at maximizing yields of tubers smaller than 40 mm (North American market) or 50 mm (European market) in diameter. Production practices should be suitably modified to optimize yields of small tuber profiles. Some of the major challenges are:

- Identifying high yielding cultivars with smaller tuber size profile and superior culinary characteristics adapted to local agro-climatic conditions.
- Can standard commercial table potato cultivars be used to produce small potatoes economically?
- What is the optimum size of seed-tubers and seed piece spacing for producing greater proportion of uniform sized small potatoes?
- How to manage water and fertility for a crop that is top-killed early in the season (i.e. prematurely) in order to maximize the proportion of smaller tubers while restricting over-sizing.
- What is the optimum size of seed-tubers and seed piece spacing for producing greater proportion of uniform sized small potatoes?
- When to top-kill the crop to maximize yields of target size profiles.
- How to determine the timing of top-kill for different cultivars to maximize target tuber size grades.
- What is the potential for over-sizing for the prematurely top-killed potato crops?

A series of studies were conducted, 2007 through 2009, at the Canada-Saskatchewan Irrigation Diversification Centre, to identify superior germplasm, and to develop cost-effective and cultivar specific agronomic practices for producing 'small' potato under irrigation. This included (i) screening superior small potato clones developed by AAFC Lethbridge Research Centre and commercial cultivars suited for the small potato market, (ii) Modify agronomic practices for standard potato cultivars such as Norland, AC peregrine, Bintje, and Alpha to maximize the proportion of small tubers suited for the small potato market, and (iii) Develop agronomic practices to maximize yield of smaller tubers targeted for the small potato market.
The 2007, 2008, and 2009 growing seasons experienced variable climatic conditions that impacted growth and yield of potatoes. The 2007 and 2008 growing season was relatively warm and dry. In 2007, high temperatures during the growing season, particularly during tuber bulking, and hail damage on July 31, August 17 and August 18 caused considerable crop damage that resulted in significant yield losses in all tests.

Cultivar Choice:

Small Potato / Creamer Clones:

Twenty four 'small potato' and creamer clones were tested 2007 through 2009. Of the many AAFC clones tested, CV96044-3, V1241-1 and the private cultivar Operle, evaluated only in 2009, appeared to be superior clones. The small potato cv. Operle, tested only in 2009, was the highest yielder of all the small potato cultivars and clones. The marketable yield potential for CV96044-3 and V1241-1 across top-kill dates and production years was 5 to 10 t/ha for CV96044-3, and 5 to 12 t/ha for V1241-1. The yield potential for Operle ranged between 23 to 26 t/ha.

The optimum stage top-kill for these clones appeared to be 10 weeks from planting. Delaying top-kill by one or two weeks increased the yield of over-size tubers but did not affect marketable grade yields.

Commercial Potato Cultivars for the Small Potato Market:

The feasibility of growing commercial potato cultivars such as Norland and AC Peregrine for the small potato markets was examined in this project. Norland and AC Peregrine were included in a range of agronomic studies. The crop was grown under standard commercial management except that the seed pieces were spaced closer and the crop was top-killed earlier compared to standard practices. Under these growing conditions Norland averaged 18 t/ha of 'table grade' tubers and 5 t/ha small potato which otherwise would be graded out as cull. Correspondingly, AC Peregrine averaged 14 t/ha of 'table grade' tubers and 6 t/ha small potato which otherwise would be graded out as cull.

Seed-Tuber Productivity:

Productive capacity of seed potato is influenced by the level of tuber-borne diseases and the physiological condition of the seed-tuber. The physiological condition of seed-tuber is dependant upon several factors including the environment under which the seed crop is grown and the cultural practices employed. The physiological age of the seed can also be an important determinant on growth and productivity of the progeny. Considerable volume of information is available on the factors influencing the productive capacity of seed potato for standard potato production. It is unknown that these parameters would be directly applicable to small potatoes, especially the size of seed tubers. For example, small potato crops are harvested when the tubers are relatively small, i.e. 40-50 mm or less, compared to larger tubers harvested for traditional seed crops.

The effects of the age of seed crop (10 to 14 weeks) and the size of seed tubers on growth and productivity of the progeny were studied for Baby Boomer, Piccolo, Blushing Belle, CV-93044-3, Norland, Alpha, and AC Peregrine.

The age of the seed crop had variable effects on growth and yield characteristics of potato cultivars. The general trends indicate that age of seed crop had no effect on emergence, mainstem number, leaf area indices at flowering and at flailing, and tuber yield. There were instances with some cultivars older seed emerged one day later and produced higher marketable and over-size yields compare to earlier harvested seed crops. There is insufficient evidence to derive any conclusions and make recommendations with respect to the effects of the age of seed crop on growth and productivity of the progeny.

Seed Size:
There is considerable evidence that size of potato seed-tuber can impact growth and productivity of the progeny.

This project examined influence of seed size on growth and yield of several small potato cultivars and selected table potato cultivars, that have potential for producing small potatoes, in a wide range of studies. Seed-tubers ranging from 20 mm and 50 mm diameter were evaluated for small potato cultivars Baby Boomer, Blushing Belle, and Piccolo; and commercial potato cultivars AC Peregrine, Alpha, and Norland.

For small potato cultivars, larger seed tubers produced higher marketable yields. The relationship between seed size and yield were variable for different cultivars at different top-kill dates. For example, the linear or near linear response for Piccolo indicates that seed-tubers larger than 50 mm could have a positive impact on yield. The optimum seed size for Baby Boomer and Blushing Belle appeared to be around 50 mm. The yield of over-size tubers increased linearly with seed size. This indicates a positive yield response if tubers larger 40 mm diameter profile are considered as marketable. Except in a few instances seed size had no effect on days to emergence and flowering, number of mainstems per hill, and LAI at flowering and prior to flailing.

Further work is necessary to verify this phenomenon.

Seed Spacing:
Seed spacing affects both tuber yield and average tuber size. Increasing plant density, i.e. decreasing in-row spacing, increases yield and decreases tuber size. In this project, several within-row seed spacings were examined for small potato cultivars (Baby Boomer, Piccolo, Blushing Belle) and standard table cultivars (Alpha, AC Peregrine, Bintje, Norland) with the objective of optimizing yields of smaller size grade (20 mm – 40 mm) tubers. Spacings of 15 and 20 cm were studied for small potato cultivars and spacings of 10, 15, and 20 cm were studied for the standard commercial cultivars.

Cultivars responded differently to within-row seed spacing in the different years. Generally closer spacing produced higher marketable yields than wider spacing. The effect of seed spacing on over-size yields were less evident than marketable yields..

Nitrogen Management:
Potato is a heavy user of nutrients. The quantity of fertilizer and timing of application is critical to maximize tuber yields and improve quality, particularly under Saskatchewan's relatively cool and short growing seasons. For small potato production, the crop is top-killed relatively early, to restrict tuber bulking, compared to conventional potato crops. Top-kill can occur relatively early in the crop growth cycle before the crop reaching physiological maturity. It is essential that sufficient nutrients are needed during the early growth stages. Therefore, it is likely that fertilizer recommendations used for standard potato production may not be suitable for 'small' potato production.

This study, conducted 2007 through 2009, examined the effects of rate and timing of nitrogen on growth and productivity for four small potato cultivars (Baby Boomer, Blushing Belle, Piccolo), and two table potato cultivars (AC Peregrine, Norland, Alpha) grown for small potato market.

The optimum nitrogen for the small potato cultivars and AC Peregrine and Norland appears to be between 200 and 300 kg N/ha. The higher rate of 400 kg N/ha depressed both marketable and over-size tuber yields.

In order to determine whether higher amounts of nitrogen would be necessary for small potatoes that are top-killed early in the crop season, one-time application at planting and split application, half at planting and half at second hilling were compared for the small and table potato cultivars.

In two out of three years single and split application of nitrogen produced similar marketable and over-size yields for all cultivars tested. In one year, for Piccolo, AC Peregrine, and Alpha, split applied nitrogen produced higher marketable yield than single application of nitrogen.

Top-kill Techniques:

Small potato crops are top-killed prematurely to limit tuber sizing and to produce smaller tubers required by the target markets. In practice, top-kill stage of the crop is determined by test digs. Usually the crop is top-killed when two tubers per hill have reached the target size grade. Depending upon the vigour of the crop and the effectiveness of top-kill, there is a possibility that the tubers will continue to bulk even after top-kill resulting in higher proportion of unmarketable oversize tubers at the expense of marketable tubers. Delaying top-kill can result in more, unmarketable, oversized tubers. This is particularly important for vigorous late maturing cultivars with delayed senescence.

A series of inter-linked studies were conducted to examine the effects of top-kill methods and timing on marketable yield for dedicated small potato cultivars (Baby Boomer, Blushing Belle, Piccolo) and for standard table potato cultivars (AC Peregrine, Alpha, Norland). Top-kill methods (i.e. flailing followed by desiccation with Reglone, and desiccation with Reglone without flailing), and top-kill timing were studied. Top-kill timing was determined when two tubers per hill reached 40 mm in diameter for the various cultivars.

In most instances, the two top-kill methods, i.e. using Reglone without flailing and flailing followed Reglone application produced similar marketable yields. However, top-kill with Reglone without flailing produced higher oversize yields compared to combined flail followed by Reglone application. Flailing and Reglone combination is a recommended option as flailing is likely to restrict further tuber bulking and Reglone will accelerate haulm die down and promote tuber skin set.

Delaying top-kill by one week had no effect on marketable yields, but increased the yield of oversize tubers compared to early top-kill. This increase in oversize yields did not occur at the expense of marketable yields. This is an indication that there is potential for further increasing marketable yields with refinements agronomic practices and harvest management.